SOCIETY FOR ADVANCEMENT OF MANAGEMENT

Advanced Management

COMBINED WITH MODERN MANAGEMENT

New Emphasis on Time Study and Methods

IN THIS ISSUE

- *Incentives for Quality*
- *Materials Management*
- *Learning Curves on Log-Log Paper*
- *Method Analysis by Motion Pictures*
- *Which Method is the Best? Part II*
- *Time and Methods Study in Heavy Industry*
- *Basic Policy for Time and Methods Studies*

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CONTENTS

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Basic Policy for Time and Methods Studies

By R. CONRAD COOPER

Vice-President—Industrial Engineering
United States Steel Corporation

A statement of the mutual interests of employee and corporation and the essential guarantees that protect both.

THE current labor agreements between the steel producing subsidiaries of United States Steel Corporation and the United Steelworkers of America (CIO) contain provisions with respect to performance standards under any new incentive to the effect that:

> "The performance standards shall: be established for a specified set of conditions; reflect the performance requirements as related to a fair day's work for a fair day's pay; remain unchanged as long as all of the conditions under which the standards were established prevail; become null and void when and if conditions under which they were established are changed; and be replaced by new standards which as compared to such expired standards shall reflect only the change of conditions."

The importance with which those provisions are viewed in United States Steel and our opinion regarding their relationship to practical time and methods studies in the operations of steel production are illustrated by the following paragraphs, all of which are contained among our official Industrial Engineering policy statements:

MUTUAL PROTECTION

In practice those basic principles protect the mutual and respective interests of the employees and the Company. The employee is provided with the guarantee that the performance standards, once established for a specified set of conditions, are guaranteed against change as long as those conditions continue to exist, and even if the conditions change the performance standards will be adjusted only to the extent of the changed conditions. The Company is provided with the guarantee that at all times the performance standards shall reflect the performance requirements as related to a fair day's work on the jobs as they exist. Both parties have the assurances that: when the performance standards are met, value is received for services rendered; when the performance standards are exceeded, the employee receives appropriate reward in direct proportion to extra performance and the Company receives proper return in the form of extra service; and that it is mutually beneficial to achieve and sustain the highest attainable level of performance.

Nothing less than a sound structure of fair performance standards, accurately determined, correctly applied, and properly maintained, can comply with those principles and endure the test of time. Thus the work of determining fair performance standards is an important and exacting undertaking.

A sound structure cannot be built on an unstable foundation. In addition to the procedural difficulties and impracticalities of determining, applying, and maintaining accurate performance standards for unstandardized jobs, important aspects of operating economies and human reactions are involved. Such matters must be taken into account. For that reason, and because performance standards must be established for a specified set of conditions and thereafter apply only to those conditions, the detailed time study of a given operation, for the purpose of determining performance standards, should not be conducted until the proper conditions for that operation are determined, specified, and established as standard practice. Thus a preliminary analysis of each job is required.

The preliminary analysis of jobs is a function of the time study procedure. However, before such work is undertaken, it should be understood that the sole function of the time study observer in the preliminary analysis of jobs is to determine the facts as they exist and the reasons therefor. The uses to be made of such facts in the determination of proper standard practice require the specialized knowledge of operating supervision and methods or process engineers. Such determinations and the establishment of new standard practice, or any necessary adjustment of existing standard practice, however, should precede the final, de-

tailed time studies to be used for the determination of performance standards.

BUILDING THE FOUNDATION

The preliminary analysis of steel producing and manufacturing jobs requires the investigation and study of some difficult technical problems. However, the most important conditions to be encountered and understood are those of human reaction to the time study procedure. Proper reaction and response are directly proportional to the care with which the purposes of time study are made known to the interested parties. The preliminary analysis of jobs can serve effectively in that connection.

It must be recognized that the maximum results obtainable from a job will be less than satisfactory to the affected employees and the Company in any given instance that involves: (1) substantial waste of the employee's time through required idle time, avoidable delays, or the requirement to perform unnecessary work; (2) unbalanced distribution of work loads as between jobs of a machine or process crew or as between crews; (3) unnecessary or extensive abnormal effort; (4) needless exposure to abnormal working conditions or hazards; or (5) difficulties of operation caused by avoidable failures to provide effective facilities, equipment, processes, or services.

PRIMARY OBJECTIVES

Thus the objectives of the preliminary analysis of jobs are to: (1) check the conditions actually in effect and compare them with those specified in the existing standard practice if such is established; (2) determine whether the work loads of related jobs are in reasonable balance; (3) determine whether any of the undesirable conditions outlined in the preceding paragraph are involved on the jobs and, if so, for what reasons and to what extent; and (4) supply such necessary and related information as the basis from which existing standard practice may be reviewed and improved, if possible, or satisfactory standard practice may be developed, if such is not established.

Process allowance or inherent delay allowance is necessary if, on the given job, the employee is required to be idle. The preferred course of action in the interest of the employee and the Company is to remove the source of such required idleness. Failure to do so imposes an undesirable condition on both parties, and during such period of time as the required idleness remains as a part of the job. For example, if the required process or inherent delay allowance is equal to half of a given employee's time on the job, that employee's ability to perform at or above the rate of a fair day's work is limited to the other half of the time on the job, and the wasted half of the employee's time is a direct loss to the Company. On the other hand, if that condition is corrected by removing the cause of idleness, both will benefit.

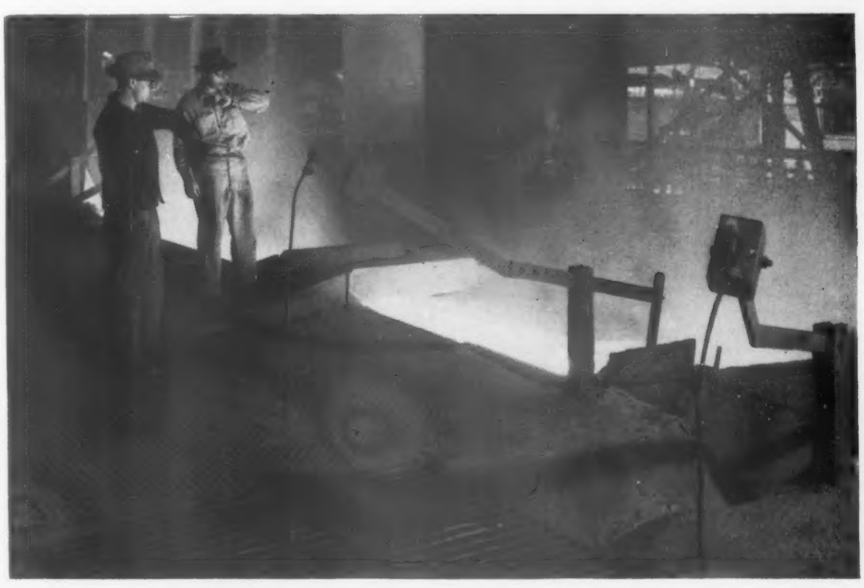
In addition to the effects upon performances and costs, the undesirable conditions previously outlined have important bearing upon employee morale. Unequal distribution of work loads, where such is unnecessary, can be the source of great irritation.

For example, assume that the operation of machine A involves no required idle time and at capacity operation the available work is 135% of a full fair day's work. The employee who actually performs that work is credited with a performance of 135% for the day. Such employee and the Company each receive exactly the return to which they are entitled respectively.

Assume that at capacity operation of machine B another employee is required by conditions of the job to be idle half of the day and can perform work at a rate 35% above that of a fair day's work during the other half of the day. The employee who performs that work actually performs only 68% of a full fair day's work. Such employee, however, is not at fault and the advance inclusion of the exact required idle time allowance in the performance standards credits the employee with a performance index of 118%. Thus the employee receives exactly the return to which entitled, but the Company pays for 50% of a day's work not received. In other words the Company buys and pays for a half day of the employee's time but does not make use of it.

DOUBLE-BARRELED COMPARISON

Unfavorable comparison can be drawn by either employee. Assuming the same kind of operation on both machines, the employee on machine A receives a lower standard time value per piece of production than does the employee on machine B and to the former employee that may appear to be unfair. Whereas the employee on machine A consistently can perform at an index of 135% and be paid accordingly, usually the employee on machine B cannot exceed an index of 118%, and to the latter employee that condition may appear to be unfair. The plain truth of the matter, however, is that both employees receive fair treatment as related to the circumstances at hand, but the real difficulty lies in the circumstances, in the fact that



One of the two world's largest blast furnaces. The men who run this equipment look to the corporation's basic policy for mutual protection of performance standards and incentive reward.

required idle time, which serves no interest, is involved. It is self evident that removal of the source of the required idle time, if practicable, is the constructive, and hence proper, solution.

DEVELOPING UNDERSTANDING

If the maximum of benefit for all interested parties is to be realized, the preliminary analysis of jobs, the subsequent determination and establishment of standard practice, and the ensuing detailed time study procedure for the determination of performance standards must be handled in light of the knowledge that the average employee is a self-respecting human being who: does not expect something for nothing; works for a living and is willing to deliver service for value received; will meet fairness with fairness or vice versa; knows the intimate conditions of his job perhaps better than anyone else; and who desires to have the satisfaction of performing well on whatever job he occupies. He cannot be expected to be industrious in the presence of waste or needless frustration. His natural inclination is to be suspicious of things he does not understand and to resent actions of a time study observer with stop watch in hand who may seem to be checking his actions as an individual, particularly if the job requires him to be idle or contains other unsatisfactory performance aspects.

On the other hand, if he understands at all times: that it is the job that is under consideration; that the first purpose of the study is to improve the job and its performance opportunities in every practicable way; and that the procedure intends nothing but fairness based on facts, he can contribute invaluable service to those ends.

Likewise the department foremen and higher supervisors must understand the time study procedures and objectives. They must appreciate the fact that sound time study is but one of the essential procedures aimed at improving the enterprise for the mutual benefit of all interested parties. Again it must be understood that the study is directed at the job, not the supervisor's management of the job. Supervisors, and they alone, can bring about improvements in the jobs. Thus to the extent that improvements are made, the credit truly rests with the supervisors. In other words time study can supply the facts but the supervisors must supply the intelligent and constructive use of those facts.

If the job under study is part of a certified collective bargaining unit, the employee's grievance or assistant grievance committeeman may play an important part in securing the benefits to which the time study procedure is directed. It is his obligation to represent the employee as needed. He is entitled to full knowledge of the procedures and objectives. As in the case of all other interested parties he can make a vital contribution if he understands and appreciates that the objectives are no more and no less than fair performance standards, accurately determined, correctly applied, and properly maintained.

SPRING-BOARD FOR ACTION

Thus the preliminary analysis of jobs serves vital purposes. It provides the opportunity to bring about initial understanding of time study and the ends to be served by the application of its procedures. It develops the facts from which to make such improvement of the jobs as may be practicable. It provides initial information for the detailed time study of the jobs required to determine the performance standards after the proper conditions of the jobs have been determined, specified, and established as standard practice.

ADVANCE NOTICE

Chapter and Date	***Subject and Speakers***
Greensboro April 21	"Materials Handling", a full day conference sponsored jointly by ASME and SAM at Winston-Salem, N. C.
St. Louis April 17th & 18th	Methods Study and Work Measurement Clinic under the direction of Professor Ralph M. Barnes. For details write St. Louis Chapter, P. O. Box 4033, St. Louis 21, Missouri.
Detroit April 18	"Material Handling Planning and Analysis", W. J. Dernberger, Supervisor of Material Handling, Ford Motor Company.
Detroit May 2	A. B. Cummins; Professor, School of Business, Western Reserve University, Cleveland, Ohio. Subject—"Statistical Methods as Related to Time Study".
Atlanta May 9	Dinner Meeting speaker, William Wallance, Executive Director, The Savings and Profit Sharing Pension Fund of Sears, Roebuck & Co. Employees.

"Developing visual proof that the method is practical and the rate accurate."

Method Analysis by Motion Pictures

By Wm. A. VOGLER, Industrial Engineer
and T. RANDALL DUBOIS, Works Manager
The Ramsey Corporation

How the camera can be the answer to some of the most difficult methods and incentive problems.

THE history of our company and the use that it has made of scientific methods of management probably is typical of many small manufacturing plants which have developed from small beginnings during the past thirty years. We have met the same problems that arise in every rapidly growing organization. Our methods of attack and our solutions to many of these problems are in no wise unique. However, we did realize somewhat recently, that we would have to make some radical departures from common practices and cut a new pattern that would fit our own individual needs.

In the first two decades of our history, we grew from a shop with one employee to a two plant organization with some 500 or 600 employees. We were operating as a Union Shop, with straight piece work as the basis of compensation in all production departments. The piece rates had developed from time studies made by foremen and superintendents, men who had gained some knowledge of scientific management from short courses, text books, and practical experience. Perhaps it was a typical example of a little knowledge being a dangerous thing. The rates were either too low or too high. Operators had no confidence that they were established rates. By mutual agreement they fixed the output and their earnings based on day rates and plus percentages of the day rates as fixed by the Union Contract. For all practical purposes, we had no incentives.

REVIVING THE INCENTIVE IDEA

With affairs in this state, we entered into the third decade of our industrial life. Management realized that while we were apparently stymied, we had several courses open. Our first objective was to re-create incentive. We knew that this could only be done by good industrial relations which included mutual confidence between men and management. Piece rates, once established, must be so firmly fixed that all increases in earnings would be accepted in good faith by management. In the past ten years, we have had to live with some terrible rates, but we accomplished our purpose. Our men know that we never change a rate once fixed for a definite job by a definite method. As a consequence, we have re-established incentives and our men are earning according to individual ability.

Our men are now educated to know that there are two fundamental elements to every time study and the resultant rate—the job to be done, and the method to be used. Any departure in method is now accepted as a legitimate reason for a rate change. We were subject to many bitter battles between men and management before we reached a satisfactory mutual agreement. We never compromised on basic principles. We put all methods in writing to the most minute detail and left little or nothing for argument when a change in method was discussed.

DRIVE FOR ACCURACY

The first move towards the establishment of accurate standards was made by consulting Industrial Engineers. We had war contracts on hand, production was urgent, and we needed outside advice on method improvement and standards. We obtained reasonably satisfactory results until the start of re-conversion to post war activities. The application of

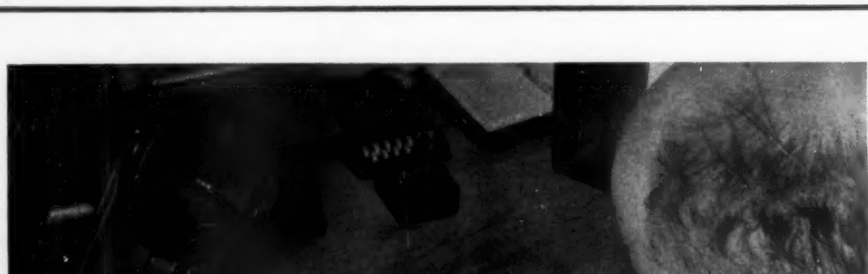
new methods, some of which involved multiple machine operation, created grievances by the men and charges by them of unfairness on the part of management. This was moving in the opposite direction to good relations. An outside consultant, representing management in such discussions with our workers, was always in a difficult spot in trying to prove that the method and the rate were correct. Supervision, at the foreman's level, was often unconvinced that either method or rate was correct. The time study engineer had no good way to prove his case. His stop watch and his slide rule were looked upon with suspicion because neither foremen nor operator could follow or check.

The next step was to engage an industrial engineer on a full time basis. This solved none of our difficulties. The new man in our organization failed to first win the confidence of either men or management. The best move that he made was to introduce a course of time study by elemental motions. This course was taken by superintendents, foremen, supervisors, and a small group of operators. The theory was that a few elemental movements made up any cycle of operations, that these elemental movements had been accurately timed by experts, stop watches were obsolete, or were used merely to check complete cycles. The course failed in one objective because labor forced the interested individual operators to withdraw after a few lessons. The course was successful in creating greater interest among the foremen and supervisors in the fundamentals of time and motion study—making the next move possible.

DEVELOPING OUR OWN MAN

This step was to place a man who had worked himself up in our own organization in charge of industrial engineering. The man chosen is the co-author of this article. He had completed the time and motion study course mentioned above, he supplemented this with courses at Washington University of St. Louis, and joined the Society for the Advancement of Management. His department was charged with the study of the best methods of performing the operation to be rated, as well as fixing a standard and a rate. As aides, he had a capable tool and die maker and a tool room machinist. These two men use the facilities of the tool room but work directly under the Industrial Engineer. Only certain jobs require such extensive method study but they represent the type of job that previously caused so much trouble with loose rates or exhaustive grievance disputes.

After a new method has been proved with tools and fixtures devised for most economical operation, the time study man goes to work. In the beginning, he continued to use the stop watch, supplemented by elemental motion times and various fatigue allowances. From the good industrial relations angle, we had arrived at about the half way point in obtaining our objective. Our supervision had been educated by the motion study course and could follow the rate study. To simplify relations with the foreman and later with the men, each job to be rated was completely analyzed and a Job History compiled. This included every detail of the method to be employed, all tools and fixtures were listed, machine feeds and speeds were fixed, and in certain cases, allowances were made for material differences which were effective on approval of supervision. This Job History was submitted to the foreman of the department, carefully analyzed by him, and approved before any rate was fixed. The methods and the rates were then explained to the men involved through the Personnel Department and the Union representative. By following this course carefully and rigorously, we could usually get agreement with the men to try out the method and the rate on a 30 day trial basis.



Preparing a "process-flow" chart from the film for methods improvement analysis.

Then new difficulties arose. The men were skeptical and often ganged together to defeat both method and rate. To prove that time was being lost by idleness, the Industrial Engineer installed time recording instruments and charts in his office. The instruments were wired to the machines under study, and the charts at the end of the day showed exactly the time that each machine was in operation. The chart was compared with the operator's time card, prepared by the operator himself, recording all time out for personal reasons, set-ups, tool changes or other reasons. The chart and the time card had to agree or the grievance on the part of the operator was invalid. We still had to convince the operator that the cycle time and set up allowances were correct. Certain men responded to education on measuring time by a stop watch, others resisted. When a grievance developed, and we wanted an airtight case, we discovered that there were certain inequities in elemental motion time standards.

INTRODUCING THE CAMERA

This led to the purchase of motion picture equipment in order to establish

for ourselves accurate elemental time allowances. Research developed that the motion picture equipment on the market was totally inadequate for our purpose. The machines operated at speeds of 16, 32, or 64 frames per second. In the latter case, a frame represented a time interval of .015625 seconds, a very clumsy base unit, subject to considerable error when used for lengthy computations. Mechanically also, these speeds were only nominally correct. Variations in motor speeds, change of voltage, friction, and other factors made precision impossible.

We found the *Bell and Howell Company* co-operative. They analyzed our problems. They have incorporated certain changes in their standard Model F 16 millimeter specialist cameras, electrically driven by a speed controlled motor, and designed with a turret head and a magazine to hold 400 feet of film. This camera is furnished to us calibrated for speeds of 1,000, 2,000, or 4,000 frames per minute. On the slowest speed, a frame represents a time interval of .001 minute. Here is a base unit that makes computations easy and accurate. An operator with no mathematical ability can easily follow the simple computations required to show the time required to make a motion, or a complete cycle.

The camera, especially at high speeds, can register movements that are so fast that they were previously unobserved by the eye. It is the old adage, "the hand is faster than the eye." The standard is then based on the accumulated time required for each motion necessary to perform the operation. It is unnecessary to tell a time study man that false or excessive movements are easily eliminated in such a study. It is also self evident that a slow motion showing of the corrected film on a small screen will allow an operator to observe his own work, check his own time by counting frames and by observing his mistakes, if it is a question of correcting a method.

Here we are a little ahead of our story, because the Industrial Engineering Department first carefully studies each film after a motion picture of an operation has been made. The technician assigned to the study uses a shadow box with a small screen inside, approximately 8″ x 12″. He writes a process flow chart and puts the time elements on the process flow chart as the film is projected, frame by frame. He records false motions, idle time of either or both hands, and suggestions for changing the method. The film is then projected on a larger screen for the benefit of the Industrial Engineer and his staff. We analyze and determine what further improvements can be made on the job.

Checking operator's time card against Time Recorder Chart.

PROVING BY DOING

If the improvement requires a mechanical change, the mechanical staff works out the improvements in the adjoining methods room. After all improvements have been assembled, the job is ready to be re-analyzed. When the job is filmed again, one of the staff employees performs the operation exactly according to the specific procedure established for the operation, so that the proper elemental time standards can be seen and recorded. This procedure is repeated until the job is approved by the Industrial Engineer and the Foreman of the department. The Job History is prepared, the rates are calculated, and both are presented to the employees involved. The film is a complete record that the job can be done in the specified time and by the method described. Arguments to the contrary are very difficult to maintain.

If time and space permitted, it would be interesting to describe each stage in the development of a new method and the resultant new rate. It would show how we use the camera in the initial stage and how we actually eliminate the unnecessary motions until the procedure becomes highly efficient. At the end of our study, the job requires a minimum of effort to perform effectively, and the operator quickly learns the established method.

We are certain that the best way to show all of the details of our process is by the very means that we are using; that is, by a film that follows the process step by step. We are working on this film, and when it is completed, it will make a highly interesting sequel to this article.

In conclusion, we can state that we have developed our method and time studies by the use of camera and projector to the point where we can prove to the Union or the operator that the method is practical and the rate is accurate by visual means—a picture of the exact process in the exact time that it requires.

Incentives for Quality

By Professor W. A. MacCREHAN, JR.

Dept. of Administrative Engineering,
New York University

Can the inspection function be geared to increased productivity without inflating costs? A well-designed incentive plan shows how quality can be maintained and some old inequities eliminated.

THE year 1950 finds manufacturing competition keen! Rising material and labor costs, higher taxes as related to a slower rising sale price create a problem that necessitates more productivity from fixed expense facilities. Scientific management tools are assisting in reaching this goal.

Motion study is contributing ease to the operation for the worker and the machine. Job evaluation is establishing procedures to categorize proper duties of each operator. Standard data and improved leveling techniques are being used to estimate unit production time with better fairness to the worker and the company. Organization studies have placed realistic values on staff and line relationship. Supplementing these techniques, the system of providing an incentive for the worker to do more than base requirements, and in return receive pay proportional to output over base requirement, has been a stimulus to meeting standard costs. This system takes many forms, "share the melon plant wide," area group incentive plans, and individual worker output incentive systems.

RELATING INSPECTION TO COST

Each plan tries to include a guarantee that the quality of the work will not materially change due to more rapid operation by the worker. Relating this premise to load factor on bench inspection, as the incentive plan creates more productivity on the part of the workers, the volume of material inspected will increase. Two choices are open, (a) hire additional inspectors (b) established inspectors must keep pace with the load.

More inspectors would add costs. This would tend to partially minimize the gains of greater productivity from the incentive producing workers. The consideration of adding more work load to an inspection station involves a fundamental question that has been a perpetual bone of contention. Is the inspector part of the production team or is the inspector a representative of design engineering?

Consider the situation where the inspector is part of production. A dimensional characteristic deviates slightly beyond the rigid specification. The inspector is aware the parts are needed, and he is also aware that in the past, deviation allowances have been granted to similar parts. Pressure of production might well add a bias toward accepting the material.

When the inspector reports entirely to the design engineering section and is their representative, the friction between the production minded foreman and the specification minded inspector often becomes a serious factor. Industrial experience has shown that the usual solution is for the chief inspector to assign "tight" inspectors to the early stages of the process and more "liberal" minded inspectors to the assembly or final stages of the process.

A corollary question at this point may well be asked: "How was the inspector chosen?" The general practice is to take an employee who has performed better than average work in the production line and with some training on inspection procedures, turn him loose in the factory as an inspector. As his ability improves, various pay adjustments advance the tyro inspector to a bench inspector, from bench inspector to a roving inspector or spot checker and then the top job is usually a combination of trouble shooter and special assignment inspector. The load limit of these grades is somewhat proportional to their pay scale.

QUANTITY AND QUALITY

To require a fixed rate inspector to flex elastically as the volume of material to be inspected varies, and yet maintain a fixed inspection efficiency requires either an employee with an unusual degree of company loyalty or an additional motivation beyond the fixed rate of pay, proportionate to the peak of inspected output. The latter works in reverse when factory troubles vary the productivity flow, for the extra high paid inspector becomes overrated for the job effort and thus the unit cost becomes out of line with sound management policies. The ideal solution would be a system whereby the efficiency of the inspector remained reasonably constant and the elastic productivity was provided by a motivation of pay proportionate to the volume of pieces inspected.

Two problems arise:

a) Standards by which efficiency of the inspector may be measured.
b) An incentive plan that will not unduly bias the judgment of the inspector as related to efficiency.

To utilize experience of others on standards for judging efficiency of inspectors, check inspection has been employed by numerous firms. Check inspection may be defined where a better qualified inspector periodically re-inspects the work of the bench inspector. This may be accomplished in two ways: (a) Rechecking pieces previously identified by the bench inspector as being O.K., and tallying the defectives found in the supposedly acceptable lot against

the total pieces in the lot. (b) Mixing both good and bad as previously determined by the bench inspector into a common lot and rechecking this lot as though it were an original lot.

Comparison of the results between the bench inspector and the superior check inspector would be a criterion to judge the bench inspector's inspection efficiency.

Experience using the above systems indicate an efficiency of 85% to 93% as being normal. This method of grading the efficiency however is difficult to accomplish where visual inspection occurs or where gauging methods permit "feel" to be a related part of the measurement.

Tests on 100% inspection have shown monotony and fatigue are proportional to the number of pieces above a certain number (which varies with the inspection operation and the part). The related efficiency of the inspector is tied quite closely to the monotony and fatigue curve for a short period and then stabilizes itself according to the inherent ability of the inspector.

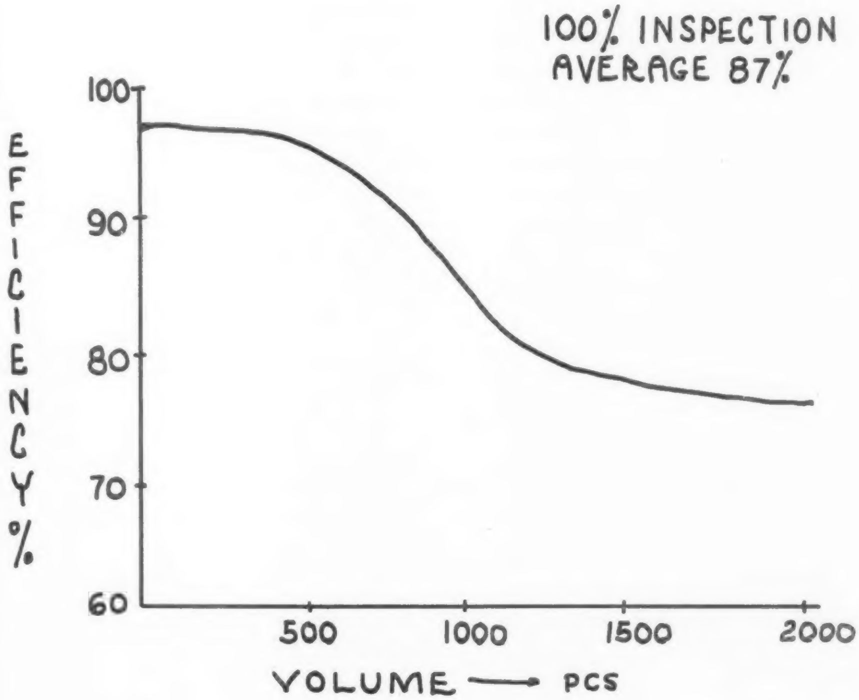
Tests of a similar nature performed when statistical sampling plans were used, showed a high degree of efficiency where a cycle consisted of inspecting a lot, weighing the good and the bad in accordance with the statistical plan, and rendering a decision of accepting or rejecting the lot. However when this same inspector was forced to detail inspect the rejected lots, then the original monotony and fatigue pattern returned to the inspector's efficiency.

BUILDING AN INCENTIVE PLAN

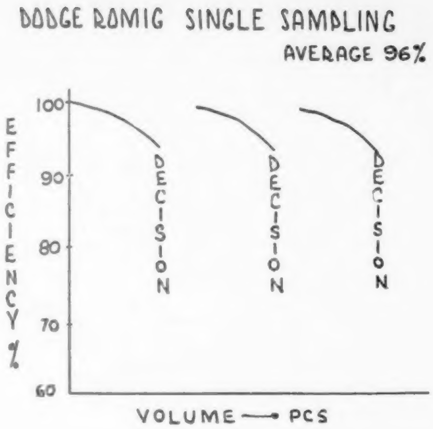
With the foregoing facts as a basis to judge the problem, the following incentive plan was derived:

I Check inspector to take a random lot of material directly from the process, inspect these parts using the same gauges as the bench inspector would use.

A. Accept or reject the lot
   a) Tag all rejects found in the sample.
   b) If lot rejected, return lot for sorting to operator if operator responsibility.
   c) Detail sort if not controllable by the operator.
   d) Compute % defective in the sample lot, forward data to the control engineer.



Results of 100% Inspection tests.



Results of statistical sampling tests.

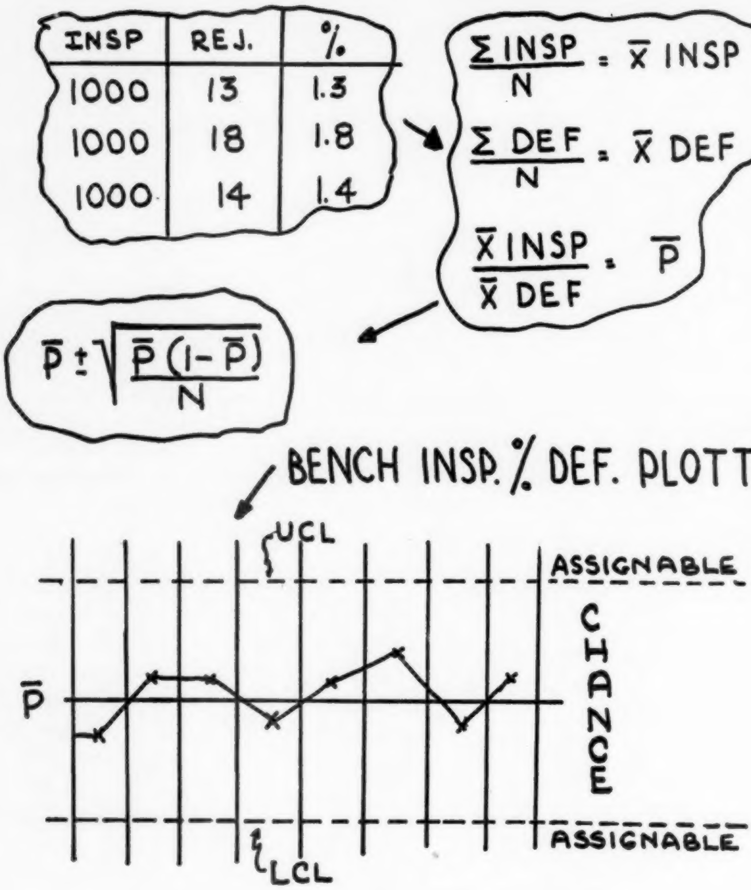
The control engineer computed a statistical "P" chart based on percent defective data of the check inspector. Normal control limits of allowable variation were calculated. As the bench inspector entered his data on a prepared form, plottings of his percent defective were put on the chart. As the lots inspected by the check inspector and the bench inspector were from a common process, the plottings of the bench inspector should check within the normal limits of the check inspector when their efficiency was on a par. When the bench inspector ran into a lot that was unusually defective, this sample percent was not plotted as the process was obviously out of control. The control limits, based on the check inspector's evaluation of the percent defective were frequently recalculated to keep pace with the quality level of the process.

The system worked surprisingly well. An "out of control" point by the bench inspector invariably was found to be assignable to a lapse in the inspector's efficiency. Checking with the bench inspector on procedure of inspection "jacked" his efficiency back into control, and further education of the bench inspector was not necessary until once again his finding of defectives in the process disagreed with the findings of the check inspector.

USING THE STANDARD

With a standard to judge efficiency, the secondary problem of incentive was placed in the following step rate plan.

I Base rate was leveled at average



Developing the statistical "P" chart.

past performance as judged by chief inspector, area foreman and inspectors involved.

(a) An inspection total of varied production items was selected which was representative of a normal production flow through the work station. (This simplified bookkeeping.)

II A direct proportionate pay scale would operate on all output over base rate.

III When flow of production slowed to lower than normal, base rate pay would apply.

IV Inspection efficiency that was not normal would forfeit incentive pay and inspector would receive base rate for that day.

V Certain areas were set up as incentive areas and when a man dropped in efficiency he was transferred to a fixed rate area where he remained for a period as determined by the Chief inspector.

RESULTS SHOW ACTION

The net results of the combined efficiency and incentive plan were startling. The elastic output level of the inspection stations rose by one-third in spite of past protestations that a peak had been reached when under a fixed rate. The follow through of the inspectors to inform the operators of quality deviations was most thorough. Hand filing of burrs left by operators stopped almost at once as the inspectors made it clear that only good pieces would be counted as being to the credit of the operator and burrs disqualified material.

The competition of being on the "first team" (incentive station) as opposed to "scrub team" (fixed rate station) kept a fine balance between the volume inspected and the efficiency of the inspector to distinguish between acceptable and rejectable pieces.

ELIMINATING AN INEQUITY

As the inspectors under the fixed rate plan were often underpaid when compared to the incentive plan workers who produced the material, the management action of bringing both the inspector and the worker into a more common pay scale made the inspector have a sense of pride in his job. The relationship between the inspectors on the line and the chief inspector's office vastly improved as the line inspectors were eager to remove any causes for production delays that would affect their take home pay; thus suggestions and reports on fault correction took on a new meaning for these men.

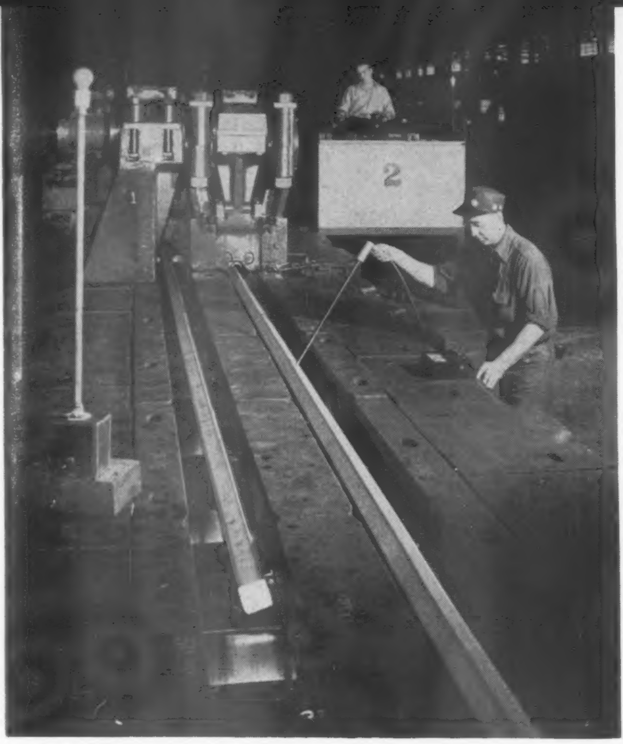
EFFECT ON IMPROVEMENTS

Valuable information that formerly never found its way into the chief inspector's office started the wheels revolving to grind out tooling improvements, material changes, blueprint revisions and above all a sense of team play. Management is often puzzled as to just how much of a load an employee can carry and still strike a fair ratio between job requirement and compensation received for the job. Yardsticks for inspection output that have grown like "Topsy" are subject to (a) Standards based on area productivity before modern machines increased output, (b) "Rule of thumb" output geared to a previously assigned inspector that held the job, (c) The accusation of "sacrificing quality for output" by the demand for more productivity.

Utilizing modern management techniques, progress can be made toward meeting the challenge of increased productivity for the 50's, both for the operator making the material and for the inspector checking the material.

TOTAL INSP	LOAD BASE	BASE RATE	INSPECTION PAY
16,000	15,000	\$1.18	$\frac{16}{15} \times \$1.18$

Calculating Inspection Incentive Pay.



Preparing aluminum bars for rolling mill operations.

Time and Methods Study in Heavy Industry

By JAMES A. HAGEN

Chief Industrial Engineer, Aluminum Co. of America, Massena Works

When investment per employee is high and the cost of making changes is almost prohibitive, Time and Methods Study takes on new significance. Here is an outline of some basic differences that influence the application of fundamentals.

WHAT do we mean by "Heavy Industry"? In spite of the freedom with which the term is used, I have been unable to find a satisfactory answer. Do we mean an industry which manufactures large machines such as railroad locomotives and cars, heavy earth moving equipment, ocean going steamships and naval vessels? Or do we mean an industry which employs heavy machinery and equipment in producing either light or heavy products?

For the purpose of this article I will confine myself to the latter interpretation. In any further references to Heavy Industry I will be thinking of an industry in which heavy equipment is used regardless of the size of the ultimate product: and conversely, I will be thinking of Light Industry as one in which light equipment is used, regardless of the ultimate product.

It is interesting to note that we find very little, if anything, in Industrial Engineering textbooks on the subject of heavy industry. Our authors follow a familiar pattern of relating their particular time study methods and formulas to drilling, milling, assembling, planing, boring, grinding, use of hand tools and other similar operations. Nothing is said about blast-furnaces, rolling mills, wire-drawing machines, extrusion presses or other tools of heavy industry. If there is any mention of the peculiar problems of heavy industry, it is usually a note to the effect that the same principles apply.

BASIC DIFFERENCES

While the fundamentals of Time and Motion Study certainly do apply equally well to all types of industry, there are some basic *differences* between these two fields which must be considered in the application of these fundamentals.

The first basic difference between heavy and light industry lies in the amount of investment per employee.

The investment per employee is always, by definition, very much greater in the heavy than in the light industries. The overhead expense of operating a machine may be many times the cost of the direct labor involved. While every effort is made to keep workers fully occupied on these high rated pieces of equipment, it is, in the interest of lowest fabricating cost, more important to eliminate idle machine hours than it is to save man hours.

It is not unusual to invest in excess of a million dollars in one piece of heavy production equipment. A single rolling mill, with auxiliaries, may be as much as 1,000 ft. long.

To show the effect of this huge investment, let us analyze the results of adding one man to an existing 20 man crew on such a rolling mill, with an expected 3% increase in production thereby:

Assumed Overhead Expense or Burden	$ 150.00/Hr.
20 Operators at $1.50 per hour	30.00/ "
Total Cost Per Hour	$ 180.00
Operating Cost Per 8 Hour Day	$1,440.00
Output Per 8 Hour Day	1,000 Units
Cost Per Unit	$ 1.44

Assuming output could be increased by 3% by the addition of 1 extra man:

Overhead expense or Burden would be	$ 150.00/Hr.
21 Operators at $1.50 per hour	31.50/ "
Total Cost Per Hour	$ 181.50
Operating Cost Per 8 Hour Day	$1,452.00
Output Per 8 Hour Day —1,000 Units x 1.03	1,030 Units
Cost Per Unit	$ 1.41

The savings would be:

$1.44—$1.41=$.03 p U.

$.03x1,030 U.=$30.90 p 8 Hr. Shift

In terms of three shift operation, 5 days per week, 52 weeks per year, this saving would amount to:

15x$30.90x52 wks or $24,102.00 per yr.

I believe this example shows why we in heavy industry must be careful, in attempting to obtain maximum efficiency from the worker, not to reduce our man power to the point where the machine operating time is reduced.

CONTRAST WITH LOW BURDEN FACTOR

In light industry, on the other hand, the direct labor cost often constitutes the major portion of the total cost of the product. If the overhead cost per unit is much lower than the direct labor cost, you are justified in sacrificing some machine efficiency if you can reduce your direct man power cost per unit.

For example, consider a light drilling operation powered by a fractional horsepower motor.

The Burden Cost might be	$ 1.00/Hr.
The Labor Cost	1.50/ "
Total Cost Per Hr.	$ 2.50
Cost Per 8 Hr. Shift	$20.00
Assumed Production Per 8 Hrs.	100 Units
Cost Per Unit	$ .20

Now assume that we can add another drill press adjacent to the present one and have the same man operate both machines. Let us also assume that *20% reduction* in output per machine will occur through this combination.

Our new cost would then be:

Burden Cost	$ 2.00/Hr.
Labor Cost	1.50/ "
Total Cost Per Hr.	$ 3.50
Cost Per 8 Hr. Shift	$28.00
Production Per Hrs. 100x2x80%	=160 Units
Cost Per Unit	$ .175

Although we have lost production per machine, we have effected a reduction in cost per unit.

Let me show this same point in another way: In studying the activity of an operator in *light industry*, we may find enough idle time in his work cycle to permit him to perform other functions during his idle time.

For instance, in a milling operation it was found that the operator had an idle period of approximately three minutes during the "cutting" element of the cycle. The parts required hand removal of the burrs left on the edges of the parts by the milling operation. This was done as a separate operation by hand filing, taking approximately one and one-half minutes.

By changing the location of the milling machine operator's work bench, it was possible for him to watch his machine in operation and at the same time remove the milling burrs from the piece previously cut. The entire cost of the second operation was thus eliminated.

While this combining of jobs might result in a few scrap pieces being produced during a day because of his divided attention between the filing and milling operations, the loss is more than made up in the savings realized by eliminating the separate hand filing operation.

In heavy industry, by way of contrast, a man activity study might show a large percentage of inactive time on the part of one or more members of the crew. However, for several reasons it might be impossible to utilize this idle time.

First, the floor space occupied by the machine is such that the work stations of the operators are quite widely separated. Their attention must be directed over a wide area to properly observe the progress of the product through their particular part of the machine, or the several dials or other observable indications of the quality or status of the product at all times.

Second, and most important, is the fact that their undivided attention must be maintained within the scope of their particular field, since the possible results of a moments laxity are very serious. As previously mentioned, the addition of a few minutes to the operating time of a large production unit can often justify the addition of a man to the operating crew. It is an obvious corollary that an interruption in the operation of the machine can result in huge losses in a very few minutes. Very careful thought and study must be applied before any attempt is made to add duties to an operator who appears to have a great deal of inactive time.

Incidentally, as a tool in securing the above mentioned "undivided attention" and in attaining the fullest possible production from so-called heavy equipment, we find our old friend, *Incentives,* to be of fully as much value as it is in light industry. Depending on the amount of machine-controlled time, increases in production of from 15% to 40% have been observed. The only difference here, from light industry, is that the cost-reductions accompanying these production increases are much greater for heavy industry, due to the tremendous burden rates involved.

To recapitulate the story thus far, we find this major point of difference in approach to heavy industry problems due to the tremendously greater equipment investment: That, in heavy industry, it very often becomes more important to get full *machine* utilization than full *man* utilization, due to higher burden costs.

COST OF CHANGES

A second fundamental difference between heavy and light industry lies in the cost of making changes in existing equipment. The cost of introducing changes in a specific operation is, again by definition, much greater in the heavy industries. More accurate predictions of the effects of change must be made before large expenditures can be justified. In lighter industries, on the other hand, it is quite often possible to set up full scale operating conditions in the laboratory for methods study; or the trial and error method of developing a new procedure in light assembly work may be less costly than attempting to perfect the new method in the drafting room or Industrial Engineering Dep't.

In light industry, you usually find large numbers of machines or assembly operations performing identical tasks so that one machine may be held up for experimental purposes without seriously affecting the efficiency or overall output of the plant. None of these conditions prevail in the heavy industries.

Methods work in many cases in the heavy industries must be directed toward better methods of producing the same product year in and year out. The general appearance of such products as steel rails, girders, angles, channels, electrical conductor cables and a host of other products of heavy industry have not changed in my lifetime. Yet im-

provements in the methods and rate of production of all these items has been phenomenal in that same period.

In the light industries, on the other hand, such as metal stampings, castings, plastics and many others, a complete change in product from year to year is not unusual.

INFLUENCING DESIGNERS

There is one answer to balancing the activity of the several members of a machine crew and the machine itself. That is to apply the principles of Motion economy, Methods analysis and Time Study in the design of the machine in the drafting board stage. It is usually too late to change a sequence of operations or relocate control equipment after a machine is delivered and installed on its foundations.

It is becoming more and more general for machine designers to embody good Industrial Engineering principles in their designs. However, beautiful looking machines which will perform every task required of them are still being built, which, with more thought given to the operators of the equipment, could have been vastly improved. Start and stop buttons placed where the operator must take unnecessary steps, or use full body movements or assume an unnatural position to reach them, are not unusual. These same controls are sometimes placed in such a position that the operator may accidently cause the machine to start or stop by brushing against them with some part of his body. They may be placed where the operator does not have the best view of the action produced by their manipulation. They may also be found where it is hazardous to the safety of the operator to reach them.

IMPROVED UTILIZATION OF EQUIPMENT

Rolling Mills are one well known form of heavy equipment. In this field, we have been able to use elemental standard times in the design of several rolling mills, as well as in the establishment of complete incentive standards in advance of actual mill operation.

In a very real sense, the use of elemental standards in rolling mill *design* is a "Methods" application, where, instead of balancing the work of a right hand with that of a left hand, we balance the amount of work done in the various mill "stands" to level out bottlenecks as much as possible. The type of mill thus far designed on these principles by our organization has been basically that known to the metals trade as the "Belgian Train," wherein a train of individual 2- or 3-high rolling mills, usually 3 to 5 in number, is driven by a single motor and set of gears, through a series of spindles and couplings; each set of rolls acting as drive shaft for the succeeding sets further down the train, and the whole turning at the same R.P.M.

In the operation of such a mill, the bloom or billet of metal to be rolled is passed back and forth through successfully smaller openings in the roll faces, being in the process progressively reduced in cross-section, elongated in length, and formed to shape.

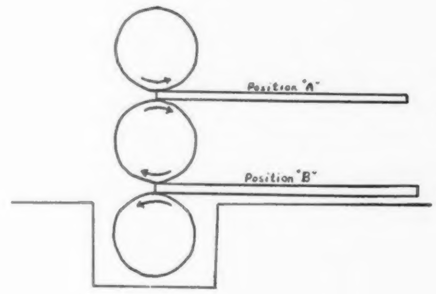
In older mill designs, it has always been a practice to have relatively more "passes" per stand in the first stands, where the bar is shorter, and relatively fewer passes in the later stands where the bar is longer and takes correspondingly longer to pass between the rolls. However, use of elemental standards for bar-handling operations and for rolling times, etc. has in several recent mill design problems made it possible to allot passes to the separate mill stands on a mathematically precise basis, the aim being to have bars in process in each stand at all times.

ANALYZING BASIC ELEMENTS

The elemental bar-handling standards which we now use for rolling mill design were developed through time studies on existing mills of various sizes. Time study results were tabulated with respect to the weight and shape of the bar being handled and the type of handling operation involved.

For example, such a table might look something like this:

This is a fundamental manual bar-handling operation, typical of rolling mill operations. In diagram, it would look like this, where the elemental time in question is that required to move the bar from position A to position B. This is done by grasping the end of the bar with a pair of tongs as it comes out of the mill, and guiding the bar to re-enter it in the appropriate lower pass as indicated.



We are all familiar with the various techniques which may be employed to arrive at the elemental standard for this operation. The important thing is that an elemental standard *is* determined and correlated with the standards for all other passes and bar weights to form a logical pattern of values.

All elements other than the manual handling elements, as given above, are determined by calculation from the known specifications of the mill.

For example, rolling time is calculated from bar weight, pass area, pass effective working diameter and roll R.P.M.

Operating times, too, have to be calculated for a variety of mechanical bar-handling equipment. If the equipment is actuated by electric motors, the calculations are based on motor R.P.M.'s and carried through whatever gear reductions exist. If the equipment is hydrau-

Operation: Catch bar with tongs as it leaves upper pass, drop to floor and enter lower pass; Stand #1, Minutes per pass per bar:

Bar Wgt. (Lbs.):	75	80	85	90	95	100	110	120
Pass #1	.030	.030	.030	.035	.035	.040	.040	.045
" 2	.030	.030	.035	.040	.040	.045	.045	.050
" 3	.035	.035	.040	.045	.045	.050	.050	.055
" 4	.035	.040	.045	.045	.050	.055	.055	.060
" 5	.030	.035	.040	.045	.045	.050	.050	.060
" 6	.030	.035	.035	.040	.045	.045	.045	.055
" 7	.030	.030	.030	.040	.040	.040	.045	.050

lically operated, the calculations start with the known capacity of the actuating hydraulic pump, and take into account the stroke and bore of the hydraulic cylinders used on the bar-handling equipment, as well as the number of cylinders which will be operating at the same time. If design is starting out cold, with *no* existing equipment to be utilized, calculations, of course, start out with the desired operating time and work toward the necessary actuating unit.

COORDINATING DESIGN AND TIMESTUDY

For mill design purposes, the data thus far listed is substantially all that is required. To balance the number of passes in the several stands, given this data, is simple mathematics; but it depends on proper correlation of Roll Design Engineering and Time and Methods Study, two functions which have not always, in the past, been considered as related. Perhaps this may be taken as an indication that Time and Methods Study can and should be a basic part of all equipment design, regardless of size and complexity. Certainly, any changes made in a mill of this type *after* its installation would involve prohibitive costs.

Turning to the question of establishing incentive standards, we see that, when a mill has been *designed* through the use of elemental data, relatively little work remains to be done. As a matter of routine check practice, however, we would start out from the beginning and figure the operating time at each stand by adding together the rolling times and handling times for the number of passes shown in the design. This procedure is quite simple in principle, but may be tremendously complicated in a mathematical way, when it is realized that a single mill may involve up to 5 rolling stands; that bar weights may vary from 20 to over 200 pounds; that the number of passes needed to produce required sections may vary from 7 to 20; and that there can be as many as 3,000 different sizes and shapes of product coming from one such mill.

Once elemental production standards have been calculated for all sizes and shapes, it then remains to apply the proper allowances to arrive at the final incentive standards. These allowances have been developed over a period of time through study or trial and error, and are now tabulated for all types of product, forming a uniform, logical pattern.

A further application of elemental data exists in the working out of estimated costs for new products not heretofore rolled. Roll Design people figure out the rolling procedure necessary to produce the desired section, complete with pass-areas and pass working diameters. From this data, roll-time is calculated, and the proper manual or mechanical bar-handling times are selected from appropriate tables and added, to develop a complete synthetic standard from which costing data may be obtained.

EMPHASIS ON ELEMENTAL DATA

In general, the lesson that may be pointed up by our rolling mill experience, is that it is possible, for any company, to develop elemental data, based on time study, for any fabricating process which is important in their field. Once this information is developed, it will be of *greatest* value, time after time, and year after year; in the design of newer equipment of the same general nature; in the working out of equitable incentive standards on new equipment or on new products, and in the obtaining of cost information on old and new products.

It might be well worthwhile to reemphasize here, the value of elemental data in heavy industry. As we have pointed out before, good methods practice must be built in to the equipment in the design stages. It is therefore *never too soon* to begin accumulating all elemental data possible, so that it will be available when new equipment is to be designed.

STREAMLINING LUMBER HANDLING

While rolling mills may be unfamiliar to some of us, we are probably all familiar with some phase of handling lumber.

Lumber is used, to a greater or lesser extent in all industries. It may be a major item in the product itself, such as the furniture industry. It may be used in boxing or otherwise packing the product, or for repairs and maintenance of buildings.

I have therefore chosen lumber handling as an example of the savings which may result from a thorough analysis combining Time Study with Methods Study, where engineering design is not a factor.

At Massena Works of the Aluminum Co. of America about 3 to 5 million board feet of lumber are used each year. It is used to fabricate the reels on which aluminum electrical conductor cable is wound for shipment. Some wire, rod and bar products are boxed for shipment, and there is a continuing program of repair and maintenance work requiring the expensive use of lumber.

Prior to our modernization program for lumber handling, lumber was unloaded from box cars and stored near the Carpenter Shop. The lumber was green and was allowed to stand in "sticked" piles in the open air for several months until the moisture content had dropped from approximately 30-35% to 12-15% before use. The area available for storage at this location was inadequate to handle the increase in lumber requirements brought about by the increasing use of aluminum products throughout the country.

The irregular arrival of lumber cars in our yards created either a feast or a famine with our limited storage space. The fact that only one or two cars could be located at the unloading stations at one time, made demurrage charges by the railroad inevitable when five or six cars were received at the same time. Because of the shortage of storage space and uncertainty of lumber shipments to our plant, we were frequently forced to accept inferior lumber from nearby sources containing too many short length boards in emergencies.

As I previously stated, lumber was received in box cars. The cars were unloaded by a crew of six men with one man in the car, one or two men at the lumber pile, depending on the height of the pile and the remaining men carrying the boards from the car to the pile. The crew could unload a car of 35,000 board feet of 7/8" x 6" x 14' lumber in about 8 hours or a total of 48 man hours per car.

All these factors combined to make our lumber handling costs just *too high.*

INVESTIGATION AND ANALYSIS

Through the cooperative action of the Purchasing Department, the Mechanical

Engineering Department, and the Industrial Engineering Department, a completely new system of lumber handling was inaugurated.

The existing lumber storage area being unsuitable for mechanical handling, a new area was chosen.

After thorough investigation of the various types of mechanical handling devices available for this work, a fork truck was selected. This truck has a capacity of 14,000 lbs., is equipped with pneumatic tires and an inclosed cab for the operator.

The Industrial Engineering Department, through synthetic time values obtained by observing the times required to handle metal bars with fork trucks, proved the economic soundness of the plan.

Arrangements were then made to receive all of our lumber requirements in bundles 4 ft. wide, 4 ft. high and approximately 14 ft. long. One railroad flat car will accommodate 12 such bundles and is the equivalent of one box car load. Each bundle is banded with two 1¼″ steel straps. The bundles are loaded two high and two wide on the car with spacers between each bundle. Four units across the car are again banded with 2 straps into one solid unit. Side stays of 3″ x 5″ lumber are inserted into brackets on the side of the car and extend about 1 ft. above the top of the lumber. These are pulled together at the top with additional bands completing the carload.

The original storage area was located at an average distance of 30 yards from the Carpenter Shop. The new area is 900 yards away. However, the speed with which bundles can be transported from the yard to the shop makes this distance a negligible factor.

During the negotiations for the purchase of bundled lumber it was found that kiln dried lumber could be purchased in place of green lumber at very little additional cost. The reduction of the moisture content by drying, reduced the weight of the lumber thereby cutting the freight charges by almost enough to offset the cost of drying.

SURVEY OF HANDLING TIME

The following exhibit, Table D, shows the time taken by the fork truck and two men to unload a typical carload of bundled lumber. The time was reduced from the previously mentioned 48 man hours to 4¾ man hours.

There is still another saving in cost involved in this operation.

When lumber was unloaded from box cars by hand and piled in the Carpenter Shop yard, it had to be brought down again, one or two boards at a time, piled onto a narrow gauge rail push car, or dolly, and pushed into the shop. To make up a four foot square load of ⅞″ lumber by this method required 60 minutes by two men.

Using the fork truck, the same bundle can be removed from lumber storage in the new location, transported and placed on the same dolly near the shop door in 13 minutes by the same two men as the following Time Study shows:

REVIEWING THE PROBLEM

In conclusion, let us summarize:

1 The principles of Time Study and Methods Improvement apply with equal force, to all industries, whether they be called heavy or light.

2 The application of these principles may differ between light and heavy industries due primarily to the greater investment in equipment per man and to the size of the equipment.

3 In heavy industry, the cost of omission of good Methods Engineering principles in the design stage is usually much greater than in the lighter industries; and therefore, Industrial Engineering principles must be given every consideration in the design and layout of heavy equipment—it is too late after the equipment is installed and the errors found by actual operation.

RECAP OF SURVEY ON PROCESS OF HANDLING BANDED LUMBER WITH ROSS TELESCOPIC FORK LIFT TRUCK, ONE OPERATOR AND ONE HELPER

		Moving Bundle of Lumber from Yard to Carp. Shop
1. Go from Carp. Shop to Yard		3.70
2. Travel to storage area		.20
3. Position truck to load		.40
4. Lift load		.15
5. Back off truck		.25
6. Travel to Carpenter Shop		5.20
7. Position load to dolly		1.55
8. Lower load		.50
9. Back off truck		.95
10. Idle Time		
A. Talk to yard man	.25	
B. Personal	3.30	
TOTALS, Elapsed Minutes	3.55	12.90

TABLE D

RECAP OF SURVEY ON PROCESS OF UNLOADING BANDED LUMBER FROM FLAT CAR BY USE OF A ROSS TELESCOPIC FORK LIFT TRUCK, ONE OPERATOR AND ONE HELPER

		RUN NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	MINUTES TOTAL	AVE.
1. Go from Carp. Shop to yard	4.00													4.00	4.00
2. Cut bands	6.40													6.40	6.40
3. Remove stays	15.30													15.30	15.30
4. Aside stays	6.70													6.70	6.70
5. Position truck to load		1.30	.45	.85	2.10	1.00	1.20	1.45	.75	.90	1.00	.70	.90	12.60	1.05
6. Lift load		.20	.30	.25	.20	.20	.20	.20	.20	.20	.20	.20	.20	2.55	.21
7. Back off truck		.45	.25	.30	.35	.35	.45	.20	.35	.40	.25	.35	.25	3.95	.33
8. Travel to storage area		1.05	1.10	.95	1.05	1.15	1.15	1.05	1.20	2.00	1.15	1.20	1.50	14.55	1.21
9. Place spacers on load		1.15					.30		.30			.60		2.35	.20
10. Position and place load		1.10	1.45	2.00	1.60	1.50	2.05	2.50	1.55	1.30	.90	1.25	1.80	19.00	1.58
11. Back off truck		.30	.35	.50	.40	.30	.30	.30	.30	.25	.30	.25	.20	3.75	.31
12. Return to flat car		.90	.90	1.00	1.00	.90	.95	1.05	1.00	1.15	1.00	1.15	1.00	12.00	1.00
13. Return to Carp. Shop	4.95													4.95	4.95
TOTALS	37.35	6.45	4.80	5.85	6.70	5.40	6.60	6.75	5.65	6.20	4.80	5.70	5.85	108.10	
14. Miscellaneous:															
A. Adjust Ties				.40										.40	
B. Reposition load				1.50		1.20			2.50					5.20	
15. Idle Time:															
A. Talk to Foreman		.60				1.30								1.90	
B. Wait for Foreman	11.20													11.20	
C. Wait for Helper		.30												.30	
D. Personal						13.50								13.50	
TOTAL TIME TO UNLOAD CAR, Elapsed Minutes														140.60	

Learning Curves on Log-Log Paper

By **J. R. HADLEY**
The Richardson Co.

A step towards the best technique for determining "Learner's Allowances."

GETTING familiar with learning curves on Log-Log paper is one of the biggest aids for the Industrial Engineer in working with "Learner's Allowances." The following review of "Learner's Allowances" may appear elementary. It is presented to set the stage for material that follows.

WHAT IS A "LEARNER'S ALLOWANCE"?

When an employee is assigned to a job which is not familiar to him, he usually does not produce at 100% (normal) the first day on the new job; however, he will usually improve. By that we mean, he will produce closer to 100% each succeeding day.

We usually think of the period where the beginning operator produces at less than 100% as a training period. The training period on different jobs may vary in length. Also, you will find that during the training period the operator improves in output faster during the first half of the training period than he does during the last half of the training period.

By various methods the length of the training period can be determined and also the speed at which the operator improves percentage-wise during the training period.

Once this has been determined, it is a rather simple calculation to figure out how much to "allow" the operator, at any particular point in the training period, in order that it is possible for the operator to make bonus.

The "Learner's Allowance" then becomes a "table" or "chart," showing the amount given the operator, in hours (per 8 hours worked), etc., at various points throughout the training period.

"LEARNER'S ALLOWANCE" CHART

Figure I shows a learning curve of a particular operation where it took the operator 160 hours to earn at the rate of 120% (100% normal). Obviously in recapping the "Learner's Allowance" table for payroll purposes several points must be remembered.

First, of course, what is the company policy on such allowances—i.e., do you want to "allow" enough to bring the operator, for example, up to 100% or up to 120%? Obviously, it follows, that if you want to allow the difference between normal and 120%, a "normal" beginner would earn 120% the first day on the job and each succeeding day.

Second—how was the curve plotted? For example, this particular curve was plotted as follows: The average work pace for the first 8 hours worked was plotted at "8 hours experience," the average work pace for the second 8 hours worked was plotted at "16 hours experience" and so on.

Third—how fine a breakdown is needed in the table? If the operator always works 8 hours, which sometimes is not the case, the table could show allowances at 8, 16, 24—(hours)—, etc. Sometimes there should be a finer breakdown, see Figure II, (assuming for the example we are going to allow to 120%).

Hours Experience *(Accumulated)*	Hours Produced *(8 hour basis)*	Learner's Allowance *(Hours/8 hours worked)*
8	3.66	5.94
10	3.93	5.67
12	4.17	5.43
14	4.38	5.22
16	4.57	5.03
18	4.75	4.85
20	4.91	4.69
22	5.07	4.53
24	5.21	4.39
.	.	.

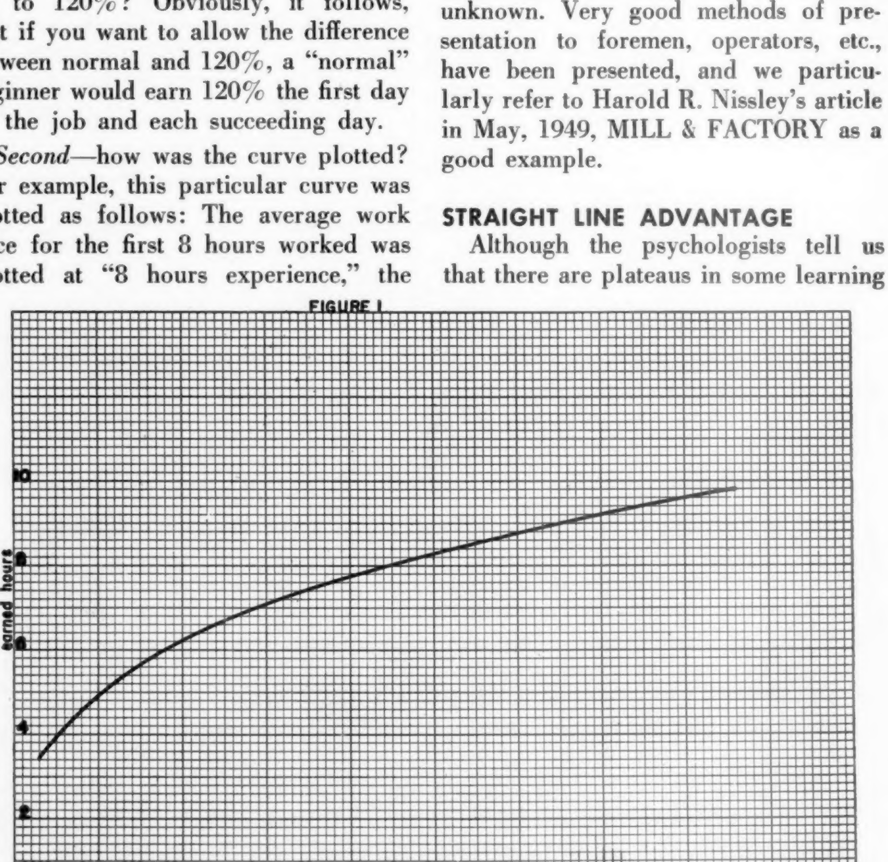
Figure II

Much has been done in many companies pertaining to "Learner's Allowances" although we are of the opinion that in general they remain practically unknown. Very good methods of presentation to foremen, operators, etc., have been presented, and we particularly refer to Harold R. Nissley's article in May, 1949, MILL & FACTORY as a good example.

STRAIGHT LINE ADVANTAGE

Although the psychologists tell us that there are plateaus in some learning

FIGURE I



curves (on cross section paper as used in Figure I), they also state that often there is no plateau; and in practice we find that not only is there usually no plateau but that we get a learning curve that is a straight line on log-log cross section paper.

While we could give some space-consuming examples, it is our purpose to try and get the reader interested in plotting learning curves on log-log paper.

Obviously, a straight line is easier to work with in developing *accurate* tables, etc., than a curve such as is shown in Figure I.

In working with straight lines on log-log paper (and to which we will confine the remainder of the article) we have two things, usually, to determine, (1) the length of training period and (2) the slope of the line.

While these two items can easily be determined by time study where there are numerous beginners on a particular job, there are times when the Industrial Engineer must forecast the performance of *one* individual or group, either actual or theoretical for estimating or forecasting purposes, and the beginners are not available for study or time does not permit an extensive study.

In order to clarify exactly what is meant suppose we illustrate, in detail, the four necessary steps and use machine coil winding (coil #X-100) as an example.

CONSTRUCTING THE CHART

Step 1—Using the 100%, standard hour plan, what is the standard?

If this is not known, the Industrial Engineer can estimate fairly close, and let us assume the standard is 60 per hour or 1.6667 standard hours per 100.

Step 2—How long should the training period be?

Again, if this is not known, the Industrial Engineer can estimate fairly close. He is familiar with the winding of similar coils, etc., and let us assume that his answer is, "12 weeks (40 hours each) to reach 100%".

Step 3—What is the slope of the Learning Curve on log-log paper?

From experience, the Engineer knows immediately that this is, say, a 90% slope. He has plotted numerous operations, and he knows that the machine-controlled cycles group around a 90% slope. The "free effort" cycles tend to group around an 80% slope. Anytime it is necessary to "cuff" a curve, it is safe to use these two %'s, depending upon whether it is a free effort standard or a machine-controlled standard. Later experience will make possible the "correction" of the "cuffed" curve.

Step 4—Development of "Learner's Allowance" chart.

We assumed that the operator did 8 hours work at the end of 480 hours experience (see Step 2) and progressed at a 90% slope (see Step 3). This means as follows:

Accumulated Hours Experience	Earned Hours Produced*
480	8.0000
240	7.2000
120	6.4800
60	5.8320

*** At any point in the training period (hours experience) the Earned Hours are 90% of the Earned Hours at double the Hours Experience.**

If we let $X =$ accumulated hours experience and $Y =$ earned hours produced, the equation of our curve is $\log Y = \log C + n \log X$. With the values of X and Y taken from the table above, we can solve for log C and n and we find them to be, $\log C = .495540$, $n = .152$.

EMPHASIS ON ACCURACY

With these figures we can now develop an *accurate* table (we stress accuracy as it is not read from a curve).

The "Learner's Allowance" would then be "issued" along the lines shown in Figure IV.

The tables could be issued in percents, if desired, and which would necessitate an additional calculation in the derivation of the tables.

Table of Learner's Allowance—Coil #X-100

Accumulated Hours Experience	Learner's Allowance (Hours)
2	4.52
4	4.14
6	3.89
8	3.71
10	3.56
12	3.43
14	3.32
16	3.23
.	.
.	.
.	.
480	.00

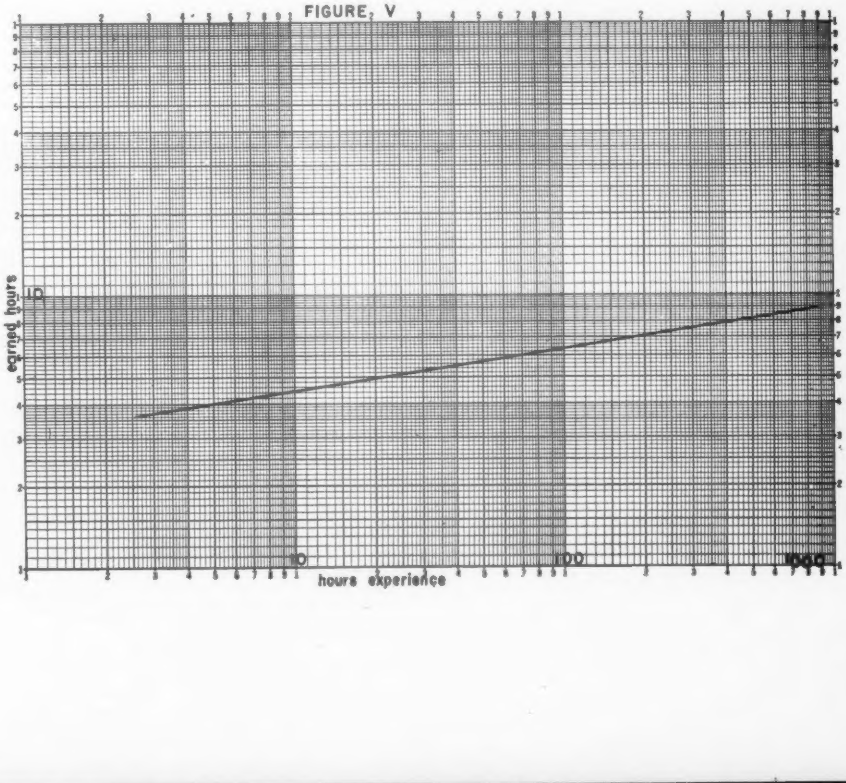
These allowances are for 8 hours (for example, if a beginner works 4 hours, he will receive ½ of the allowance, etc.)

Figure IV

Figure V shows the Learning Curve on log-log paper, and while we have verified many times that a straight line results, and perhaps the illustration was not of the best, we are of the opinion that, if Industrial Engineers will become acquainted with their learning curves on log-log paper, interesting results will be obtained.

Space limitations do not permit illustrating complete calculations supporting Figures IV and V. They are available on request.

FIGURE V



"Just an orderly flow of materials."

Materials Management

By STANLEY E. BRYAN

Associate Professor of Business Administration
Michigan State College

Today's challenge of markets, competition, and effective production puts the management of materials in a crucial position. Scientific management provides tools and guides to meet the challenge.

IN the case of no company which used Frederick W. Taylor's talents as a consultant were the circumstances such as to make it possible for him to work out a complete development of his concept of Scientific Management. The full flood of his brilliance was thus never directed specifically toward Purchasing or the management of supply.

Taylor left a legacy, however, of tools and ideas which have since been accepted. Among his contributions to the specific field of materials management must be included such factors as the following:

- Classification of materials
- Mnemonic symbolization
- Correct disposition and recorded location
- Balance of stores sheets
- Stores issue slips
- Materials requisitions
- Materials handling improvements
- Materials standardization
- Purchasing specifications
- Storage bin tags

There are other instruments of materials movement, storage, and control attributed to Taylor. Some of his pioneer ideas in this field were slow to be accepted. For example, *materials handling*, almost a new term in modern industry was referred to by Taylor as the "life blood of industry." His idea of purchasing by specification in 1894 was ridiculed as follows:

> A manufacturing concern in this city amuses the trade very much over the extreme care exercised in buying an ordinary bill of paper . . . the concern sends out a long list of specifications in paragraphs. . . . Comments are unnecessary. After all it is rather nice for the business man to be relieved occasionally by a little ripple of mirth. *(F. B. Copley, Frederick W. Taylor, Harper and Brothers, 1923, p. 447.)*

DEVELOPMENT OF PURCHASING

If the common practices of modern materials management were slow in being accepted and had a long evolutionary development since 1894 so did the function of Purchasing.

Some administrators did see the advantages of a purchasing function separated from direct production activities. William Knudsen was one of these. In using the services of a Purchasing Agent he realized that such an executive, through his knowledge of materials, markets, and buying techniques, could save the company money and increase its effectiveness. Knudsen tied up early in his mind the three functions of production as being (1) procurement, (2) follow-up, (3) making. *(Norman Beasley, Knudsen—A Biography, McGraw Hill, 1947, p. 48.)* The "boss of Chevrolet" wanted continuity and rhythm in his production supplies.

When James D. Mooney drove over to Flint to look at the assembly lines his classic comment was, "Just an orderly flow of materials." It is significant that the organization he directed was subsequently organized into four equal divisions—manufacturing, sales, finance, and *supply*. *(James Mooney at that time headed the General Motors Overseas Division. He is co-author with A. C. Reiley of Principles of Organization, Harper and Brothers, 1939.)*

The year 1915 had seen the organization of the National Association of Purchasing Agents, the appearance of the first book on the subject, the establishment of the first college course, and the publishing of the first magazine in the field, *The Purchasing Agent*, now *Purchasing.* Yet in spite of a growing recognition among progressive companies of the need for a competent supply officer his claim to top management status has been slow in being recognized.

Perhaps among the reasons for such slow recognition is the fact that production men are still likely to be unaware of the effect that goes into the effective supply of materials, and the urgent need for inventory control. Some production men look upon the Purchasing Department as a means by which they are circumvented from buying materials themselves. They might even be con-

vinced they could do a better job of buying. Who would know better their actual needs than themselves?

Yet the responsibility for expending an amount which in the average industrial company represents more than half of the dollars taken in in sales is a major one. *(The figures vary. However this statement was based upon figures for 1940 found in Sixteenth Census of the United States—Manufactures, Volume I, Bureau of the Census, United States Department of Commerce, 1940.)*

Production men bent on reducing costs in manufacturing operations may be over-looking the fact that the cost base on materials which faces them as a fixed cost may be variable up to the time they receive them. They should realize that under the eyes of specialists the cost considerations in the management of materials supply are receiving the same close scrutiny which they are giving to their own management of men and methods.

VENDOR RELATIONS

In this era of human relations production men sometimes seem to be in agreement with the description of a Purchasing Agent attributed to Elbert Hubbard, as "a human petrification with a heart of feldspar and without charm, or the friendly germ, minus bowels, passions, or a sense of humor. (Happily they never reproduce, and all of them finally go to hell!)" However, the stress on human relations has proved no more significant in any phase of operations than in vendor relationships.

Vendor relationships are so important in the assurance and adjustment of supply that Professor Schell of M.I.T. made these relationships the criteria by which to judge whether or not a particular function should be included in the Purchasing Department. *(E. H. Schell, the Scope of the Purchasing Function, N.A. P.A. Pamphlet Number 22, 1935.)*

There has been ample evidence during the past few years that vendor loyalty is necessary for successful production scheduling and pays off in design improvements and other important economic advantages. No wonder then that some students of the subject look upon the Purchasing Agent as in reality the "Director of Supplier Relations."

MATERIALS CONTROL

The writer's experience takes him back to a time in the airframe industry when materials were under the direct control of the production departments which used them. Long production runs were made in some of these departments on certain items even though the actual production orders called for only a few. In order to avoid extra set-ups the departments would gamble on an order for a similar part coming through shortly thereafter. This practice resulted in unbalanced inventories—shortages of various raw materials coupled with overages of certain fabricated components. Many of the latter had to be scrapped because subsequent design changes made them obsolete. (*Similar statements are to be found in H. T. Lewis, and C. A. Livesey, Materials Management: A Problem of the Airframe Industry, Business Research Studies Number 31, Harvard Business School, Division of Research, 1944.)*

There is also a disregard for materials evidenced by the actions of some production personnel and management people alike which is apparently based upon a certain human contempt for that which is at hand, plentiful, or easy to obtain. Thus materials control increases in importance in direct ratio with the cost of the material concerned and the amount of it which is used in production. In line with the organization principle, *criterion of separation,* materials control should be separated from the production department to allow wholesome checks and balances to be developed in the organization.

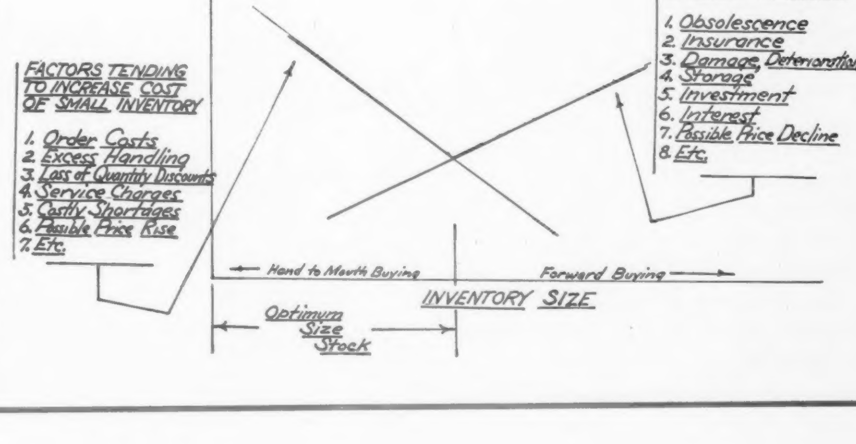
INVENTORY POLICY

No factor can prove or disprove the right to management status more effectively than that of inventory policy. The importance of inventory policy was emphasized during the early twenties. A period of "profitless prosperity" was brought to an abrupt end by a sudden fall in inventory values. Capital frozen in inventories was freed only at a drastic loss. Top management executives turned their attention to inventory policy, and inventory losses caused a top management turn-over in many companies. The prior policy of having "plenty," advocated primarily by production men as insurance against work stoppages, had proved to be wrong when viewed from the over-all good of the company. The period that followed was one of hand-to-mouth buying against current needs.

However, the forties ushered in the preparation for, and participation in, the World War II production. The period was one of continued materials shortages. This was the period in which the emphasis was on *procurement* — acquiring material at any cost was in order. Top management again turned its attention to materials, not because it had

EXHIBIT I

SOME ASPECTS OF THE PROBLEM OF INVENTORY CONTROL FACING THE MATERIALS MANAGER— TO ACHIEVE & MAINTAIN OPTIMUM SIZE STOCK.



too many, but rather because it had too few. It was the period of the expediter, materializer, and miracle man of materials. Recently most materials have become more plentiful and the "lost art" of *purchasing* is being re-discovered.

Such examples serve to illustrate that the emphasis in materials supply varies from time to time. But whether it is strict inventory control at one time, spectacular procurement at another, or artful purchasing at a third, the supply operation is of vital importance to the over-all welfare of the company. The executive who is charged with the materials supply responsibility holds a key position in the success of the firm's operations. His primary problem — a major one — is to achieve and maintain an optimum size inventory.

GROWTH CREATES THE MATERIALS MANAGER

As an industrial organization grows the supply operation becomes more complex. The pattern of complete integration, differentiation, and reintegration of functions has been followed to its logical conclusion in some companies by the establishment of a distinct Materials Department under the executive leadership of a Materials Manager.

Complete integration of supply activities is still found sometimes, usually in small organizations, where the production men do their own buying, receiving, and storing.

Differentiation of such functions is found more often and is characteristic of most companies. That is, there is a distinct Purchasing Department, Stores Department, Inventory Control Department, Traffic Department, and so on.

Reintegration is logical when too many functions are differentiated, and coordination becomes difficult. Regrouping of similar activities or activities with a common objective into larger groupings under a common executive leadership is an accepted organizational device. Among other things it reduces the number of widely scattered functions reporting to a general executive. It also breaks the organization down into logical major segments, such as (say) along the lines of Men, Methods, Money, Markets, Machines, and Materials.

Materials departments are already to be found in such industries as the airframe, airline, electronic, diesel engine, and prefabricated homes. Such departments are in charge of an executive with the title of *Materials Manager* or *Director of Materials*. Such executives are major administrators whose duties include predicting future supply situations, planning for material needs, staffing the proper organization to carry out the supply function, and controlling materials movement and storage. As guardians of the company's supply lines and inventories they are members of top management with sufficient stature so that their decisions carry proper weight. Some of them have Vice-President status. In other companies they are still called "Director of Purchases" although that title, from a descriptive standpoint, is a misnomer.

THE INTEGRATED PICTURE

In order to abbreviate a concept of materials management which includes both actual practice and empirical theory there accompanies this discussion a chart showing a "Warp and Woof Approach" to a program of materials management. Using functions as the "warp" and factors as the "woof" a definite integrated tapestry can be woven. It will be noted that like any tapestry some of the strands run all the way through while others go only part way through. But again like a tapestry the strands tie it together into well-knit unity. It depicts some of the considerations facing the Materials Manager. Being a small tapestry it depicts only a few; but it is evident from analysis that those few denominate materials management as a growing management function.

EXHIBIT II

Warp and Woof Presentation of some Organization Considerations facing the Materials Manager

WARP-- FUNCTIONS / WOOF FACTORS	MATERIAL PURCHASING	MATERIAL INVENTORY CONTROL	MATERIAL STORES AND MOVEMENT	MATERIAL MARKET STUDY AND COST ANALYSIS
OBJECTIVES AND AIMS	To economically and effectively supply the proper material at the proper time at the proper cost in the proper quantity at the proper price.			
(GOAL FACTORS)	Price & Vendor-- Effective Buying, Good Vendor Relations	Quantity-- No Shortages, Minimum Investment	Place-- Economical, Safe Materials Handling	Time-- Proper Timing and Cost Attributes
EXECUTIVE LEADERSHIP	Delegation from a top management executive whose administrative capabilities and stature is assured to men with requisite qualities to fulfill the aims.			
(HUMAN FACTORS)	Experience, Integrity, Decisiveness, Etc.,	Prestige, Perseverence, Courage, Etc.,	Vitality, Responsibility, Judgement, Etc.,	Analytical, Enthusiasm, Industry, Etc.,
OPERATIONS	Setting up effective procedures which can become standard procedures to coordinate the interrelationships between the functions and factors.			
(PROCEDURAL FACTORS)	Central Buying, Vendor Contacts, Follow-up, Etc.,	Maximum-Minimum, Material Review, Inventory Taking, Etc.,	Traffic Aspects, Storeroom Layout, Identification, Etc.,	Standard Sizes, Characteristics, Market Forecasts, Etc.,
FACILITIES	Developing and acquiring the necessary facilities to achieve the objectives through improved operations directed by competent executive leadership.			
(PHYSICAL FACTORS)	Standard Orders, Purchase Contracts, Request for Bids, Etc.,	Balance of Stores, Perpetual Inventory, Requistions, Etc.,	Bin Tags, Mechanical Lifts, Storage Space, Etc.,	Cost Analysis Forms Indexes and Statistic Specifications, Etc.,
PRINCIPLES	Developing through experience principles or guides to judgement which will make future decisions more scientific and effective. Principles of:			
(GUIDANCE FACTORS)	Functionalization, Ideals, Etc.,	Situation, Control, Etc.,	Space Utilization, Mechanical Handling, Etc.,	Analysis, Planning, Etc.,

Which Method is the Best?
Part II

by GERALD NADLER, Ph.D.

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Determining the optimum pattern for a simple task using energy expenditure calculations.

THE uses to Motion and Time Study of an a priori procedure to determine the energy expenditure involved in performing a task are to compare energy expenditures of different ways of doing the same job to arrive at the optimum motion pattern, and to have a scientific basis for determining work loads thereby replacing our present concepts of time study. The work accomplished so far and reported here is restricted in use at the present time by the limitations mentioned previously.[1]

THE TASK IN DETAIL

The experimental procedure was applied to a simple task. The task was:

A—the hand pressed down and held a button with the right thumb and forefinger,

B—on a signal the hand moved to a selector switch, grasped and turned the switch one click, or 30°, clockwise, and

C—moved back to the original button and depressed it.

The button and switch were mounted on a smooth surface inclined at 75° with the horizontal. Other conditions of the job will be brought out in the calculations and determinations connected with the steps of the procedure. This particular task is called condition 6 in future references. A subject was seated at a workplace mock-up to obtain all necessary physical measurements.

CALCULATIONS STEP BY STEP

The calculations for determining the energy expenditure for the movement from the button to the switch in this simple task are given below:

Step 1. The distance the hand moved from the button to the switch was 20 inches.

Step 2. The time for the movement was assumed to be .0045 minutes. Changing the time unit from minutes to one ten-thousandths of a minute (T), the time for the movement was 45 T.

Step 3. The time spent in acceleration was (.46) (45T) or 20.70 T, in constant velocity (.31) (45 T) or 13.95 T in deceleration (.23) (45 T) or 10.35 T. The distance covered in acceleration was (.37) (20 inches) or 7.4 inches, in constant velocity (.44) (20 inches) or 8.8 inches, and deceleration (.19) (20 inches) or 3.8 inches.[2]

Step 4. The increments of time chosen were 2 T. With the figures obtained in Step 3 a displacement graph could be drawn. This graph would illustrate the distance covered by the hands in acceleration, constant velocity, and deceleration. The equation for the line representing constant velocity was determined by first finding the slope (m). Substituting this value of the slope (.631) and the values for x_1 and y_1 into the equation for a straight line ($y = mx + b$), solving for b, and placing the values of the slope and b in the equation, the equation for the constant velocity line is

$$y = .631\,x - 5.65 \qquad (1)$$

Known information was substituted in the general quadratic equation to arrive at the equation for the acceleration and deceleration curves. For acceleration, the equation is

$$(y + 24.1115)^2 = .9606x^2 + 581.36 \qquad (2)$$

For deceleration the equation is

$$(y - 29.738)^2 = .8258(x^2 - 90x + 1068.82) + 884.41 \qquad (3)$$

For increments of time up to and including 20 T, the distance traveled was found by substituting the increments of time in equation (2). For increments of time from 22 T up to and including 34 T, the distance traveled was found by substituting the increments of time in the equation (1). For increments of time from 36 T up to and including 45 T, the distance traveled was found by substituting the increments of time in equation (3). For example, the distance traveled at time increment 12 T was found by substituting 12 for x in equation (2) and solving for Y (distance).

$$(y + 24.1115)^2 = .9606\ (144) + 581.36, \text{ and}$$
$$y = 2.715 \text{ inches}$$

Step 5. A table was made to accommodate all the necessary future calculations.

Step 6. Equation 4 represents the differentiated equation 2, and equation 5 represents the differentiated equation 3.

$$vH = \frac{dy}{dx} = \frac{x}{1.041y + 25.1} \qquad (4)$$

$$vH = \frac{dy}{dx} = \frac{x - 45}{1.211y - 36.015} \qquad (5)$$

For increments of time up to and including 20 T, the velocity of the hand (vH) was found by substituting the increments of time and the corresponding

[1] *See Part I of "Which Method is the Best?" Advanced Management, March,* 1950.

[2] *The constants used are from Barnes, R. M. and Mundel, M. E.* Studies in Engineering, *Bul.* 12, *University of Iowa,* 1936.

distance traveled in equation (4). For increments of time from 22 T up to and including 34 T, vH was equal to .631 inches per T. For increments of time from 36 T up to and including 45 T, vH was found by substituting the increments of time and the corresponding distance traveled in equation (5). The velocity of the hand for each increment of time was entered in a column of Table 2. For example, the velocity of the hand at time increment 12 T was found by substituting 12 for x and 2.715 for y in equation 4, and solving for vH.

vH=12 divided by (1.041) (2.715) + 25.1 = .4297 inches per T.

ACTUAL MEASUREMENTS USED

Step 7. By actual measurement, the height (g) of the shoulder above the floor was 37.5 inches.

Step 8. By actual measurement the height (h) of the beginning point of movement above the floor was 28.25 inches.

Step 9. Angle A was taken from a workplace mock-up and was 75°.

Step 10. By actual measurement the distance from the shoulder to the end point of travel was 26 inches.

Step 11. The angle between the intersection of a vertical plane perpendicular to the front of the operator's body and the vertical plane formed by passing through the beginning point and end point of the movement of the hand was 0°. This value was determined by actual measurement of the workplace mock-up.

Step 12. The distance from the shoulder to the vertical plane perpendicular to the front of the operator's body which passes through the beginning point and end point of travel was 6 inches.

Step 13. The projected side view of the operator and the work place is shown in Figure 1. The value, 25.298, was found by $\sqrt{(26)^2 - (6)^2}$.

Step 14. The unknown values of Figure 1 were calculated as follows:

(1) f = 37.5 — 28.25 = 9.25 inches
(2) e = 20 times sin 75° = 20 times .9659 = 19.32 inches
(3) b = 19.32 — 9.25 = 10.07 inches
(4) c = $\sqrt{(25.298)^2 - (10.07)^2}$ = 23.21 inches
(5) d = 20 times cos 75° = 20 times .2588 = 5.176 inches
(6) x = 23.21 — 5.176 = 18.034 inches
(7) y = 18.034 times tan 75° = 18.034 times 3.732 = 67.3 inches
(8) m = (67.3 + 9.25) (sin 15°) = 76.55 times .2588 = 19.81 inches
(9) $(25.298)^2 = (19.81)^2 + (20 + z)^2$ and z = —4.27 inches

Step 15. The perpendicular distance (n) from the elbow to the plane, perpendicular to a vertical plane perpendicular to the front of the operator's body in which the hand traveled when the hand was at the beginning point, was 10.5 inches. The distance n was found by actual measurement.

Step 16. With the hand at the beginning point of travel, the distance (p) from the elbow to the end point of travel was 28 inches.

Step 17. The perpendicular distance (q) from the elbow to the plane, perpendicular to a vertical plane perpendicular to the front of the operator's body, in which the hand traveled when the hand was at the end point, was 8 inches.

Step 18. The length (L_2) of the upper arm was 13 inches, as determined by actual measurement.

Step 19. The length (L_3) of the lower arm plus the hand was 16.25 inches, as determined by actual measurement.

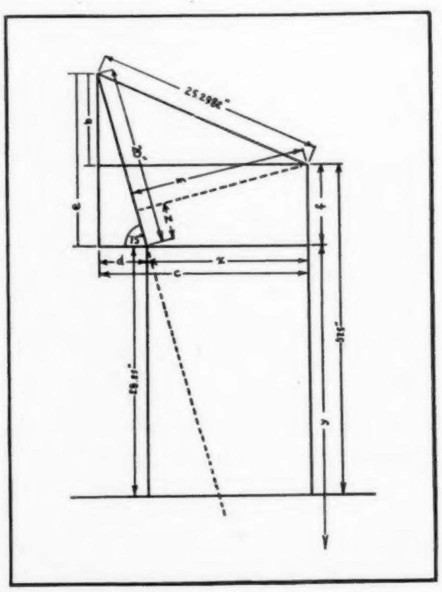


Figure I.

Side view of workplace and operator, Condition 6.

Step 20. The x-plane graph is shown in Figure 2. The path of the hand is on the left side of the graph. (The x-plane is the plane in which the hand travels, while the y- and z-plane are in respect to this x-plane.)

RELATING TIME TO DISTANCE

Step 21. The time increments are placed along side of the corresponding distances traveled in the graph of Figure 2.

Step 22. The sideview perpendicular length of upper arm was equal to 19.81 inches — 10.5 inches or 9.31 inches. The projected upper arm P in the x-plane was equal to $\sqrt{(13)^2 - (9.31)^2}$ or 9.07 inches.

Step 23. The projected lower arm R in the x-plane was equal to $\sqrt{(16.25)^2 - (10.5 - 1)^2}$ or 13.18 inches.

Step 24. The projected distance (S) in the x-plane from the end point of travel to the elbow when the hand was at the beginning point was equal to $\sqrt{(28)^2 - (10.5)^2}$ or 25.96 inches.

Step 25. The line through Cx parallel to the bottom of the graph is 4.27 inches from the beginning point of travel when measured in the direction of the top of the graph. This direction was used because 4.27 was negative. (See Step 14.)

Steps 26 and 27. The crossing of radius R and radius S is indicated by Ex or the position of the elbow at the time increment of 0 (Figure 2).

Step 28. The point on the line of step 25 in Figure 2 is Cx, the projection of the shoulder in the x-plane.

Step 29. The equation of the circle that was used to calculate the decrease of the perpendicular height of the elbow as it moved while traveling above the plane, perpendicular to a vertical plane perpendicular to the front of the operator's body, in which the line of travel lay, was found by substituting the known characteristics of the circle into the general quadratic equation.

$$(x - 45)^2 + (y - 406)^2 = 164836 \qquad (6)$$

Step 30. Values of (nx — q) were obtained from equation 6 by substitution of time increments into the equation. These values of (nx — q) were placed in a table. (nx is the perpendic-

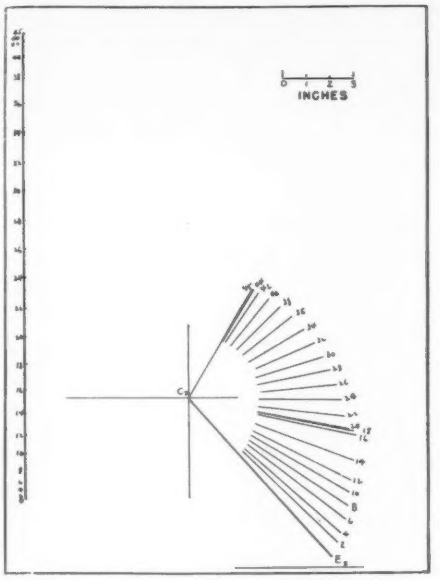


Figure II.

x-Plane graph of upper arm, Condition 6.

ular height of the elbow above the plane of travel at each increment of time. q is the perpendicular height of the elbow above the plane of travel at the end point of travel.)

Step 31. The values of P for each time increment were placed in a table. For the time increment of 12 T a value of (nx — q) + q was found by adding 1.343 inches to 8 inches and getting 9.343 inches. This value was subtracted from m (19.81 inches) to get a value of u (10.467 inches). Since L_2 was equal to 13 inches, P was equal to $\sqrt{(13)^2 - (10.467)^2}$ or 7.71 inches.

Step 32. Values of R for each time increment were placed in a table. For the time increment of 12 T, one inch was subtracted from the value of (nx — q) + q, 9.343 inches, to obtain 8.343 inches. Since L_3 was equal to 16.25 inches, R was equal to $\sqrt{(16.25)^2 - (8.343)^2}$ or 13.94 inches.

Step 33. The projected upper arm in the x-plane, depicting its movement, is shown in Figure 2. The numbers at the end of the line represent the point of the projected elbow Ex at the time increment shown.

Step 34. For each value of Ex the line connecting it with Cx is shown in Figure 2.

Step 35. The angle ax for each increment of time was recorded in a column on the Step 5 Table. For time increment 12 T, the angle measured from Figure 2 is 332.5° in relation to a line through Cx parallel to the abscissa.

Step 36. The angular displacement curve for the upper arm in the x-plane is shown in Figure 3.

Step 37. The slope of the curve at each increment of time was found by graphical differentiation. The slope or angular velocity wx for each increment of time was recorded in a column on the Step 5 Table. For time increment 12 T, the slope was determined as 2° per T.

Steps 38 through 42. Similar to steps 33 through 37, except for z-plane view. (wz was found to be .25° per T at time increment 12 T.)

Steps 43 through 47. Similar to steps 33 through 37, except for y-plane view. (Wy was found to be 2.25° per T at time increment 12 T.)

Step 48. The angular velocity w_2 of the upper arm for time increment 12 T was equal to $\sqrt{(2)^2 + (.25)^2 + (2.25)^2}$ or 3.0208° per T. The values for w_2 were placed in a column on the Step 5 Table.

Step 49. The center of gravity of the upper arm was (.47) (13 inches), or 6.11 inches (s_2), from the upper joint of the upper arm.[3]

Step 50. The center of gravity of the lower arm plus the hand was (.66) (11 inches), or 7.26 inches (s3), from the upper joint of the lower arm.[4]

Step 51. Since the angle found in step 11 is 0°, the cosine to be found in this step was the cosine of ax only. The cosine of ax for the time increment of 12 T was .8870.

Step 52. The linear velocity (v_2) of the upper arm for the time increment 12 T was equal to (6.11 inches) (3.0208 degrees per T) divided by 57.3 degrees per radian or .3220 inches per T.

Step 53. The linear velocity (vE) of the elbow for time increment 12 T was equal to (13 inches) (3.0208 degrees per T) divided by 57.3 degrees per radian or .6854 inches per T.

Step 54. The linear velocity (L_3w_3) imparted by the lower arm to the hand for time increment 12 T was equal to $\sqrt{(.4297)^2 + (.6854)^2 - 2(.4297)(.6854)(.8870)}$ or .3632 inches per T.

Step 55. The angular velocity (w_3) of the lower arm itself for time increment 12 T was equal to .3632 inches per T divided by 16.25 inches or .0224 radians per T.

Step 56. The linear velocity (s_3w_3) of the lower arm plus the hand imparted by the lower arm itself at the center of gravity for time increment 12 T was equal to (.0224 radians per T) (7.26 inches), or .1626 inches per T.

Step 57. The cosine of B (the angle between vE and L_3w_3) for time increment 12 T was equal to $\overline{/(.6854)^2 + (.3632)^2 - (.4297)^2/}$ divided by 2(.6854) (.3632), or .8377.

Step 58. The actual linear velocity (v_3) of the lower arm plus the hand for time increment 12 T was equal to $\sqrt{(.4297)^2 + (.1626)^2 - 2(.4297)(.1626)(.8377)}$ or .5563 inches per T.

BRINGING IN WEIGHT AND ENERGY

Step 59. The weight W_2 of the upper arm was equal to (.0336) (150 pounds as determined by actual measurement), or 5.04 pounds.[4]

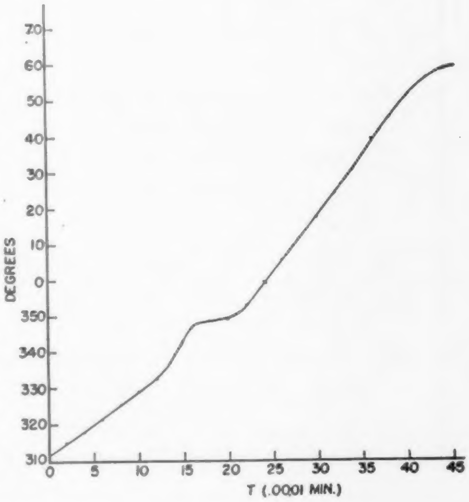


Figure III.

Angular Displacement curve for upper arm in x-Plane, Condition 6.

[3] *The constant is from Braune, W. & Fischer, O.* Abh. d. Math. Phys. Kl. d. Sachs. Akad. d. Wiss. *Vol.* 21, 1894, *Pg.* 153 *(as reported by Fenn, W. O., Fractional and Kinetic Factors in the Work of Sprint Running.* Am. J. Physiol., *Vol.* 92, 1930.)

[4] *ibid.*

Step 60. The weight W_3 of the lower arm plus the hand was equal to (.0312) (150 pounds), or 4.68 pounds.[4]

Step 61. The radius of gyration (k_2) of the upper arm was equal to (.3) (13 inches), or 3.9 inches.[4]

Step 62. The radius of gyration (k_3) of the lower arm plus the hand was equal to (.3) (16.25 inches), or 4.875 inches.[4]

Step 63. The translational energy (Tr_3) of the lower arm plus the hand for time increment 12 T was equal to (4.68) $(.5563)^2$ divided by (64.4) (12) (.000036), or 51.9952 pound-inches. (The terms 12 and .000036 correct feet to inches, and T's to seconds respectively.)

Step 64. The rotational energy (Ro_3) of the lower arm plus the hand for time increment 12 T was equal to (4.68) $(4.875)^2$ $(.0224)^2$ divided by (64.4) (12) (.000036) or 2.0080 pound-inches.

Step 65. The total kinetic energy (Tot_3) for the lower arm plus the hand for time increment 12 T was equal to 51.9952 plus 2.0080, or 54.0032 pound-inches.

Step 66. The translational energy (Tr_2) of the upper arm for time increment 12 T was equal to (5.04) $(.3220)^2$ divided by (64.4) (12) (.000036) or 18.7668 pound-inches.

Step 67. The rotational energy (Ro_3) of the upper arm for time increment 12 T was equal to (5.04) $(3.9)^2$ $(3.0208)^2$ divided by (64.4) (12) (.000036) (3283) or 7.6652 pound-inches. (The term 3283 corrects $(\text{degrees})^2$ to $(\text{radians})^2$.)

Step 68. The total kinetic energy (Tot_2) for the upper arm for time increment 12 T was equal to 18.7668 plus 7.6652, or 26.4320 pound-inches.

Step 69. The total *increases* in kinetic energy of the lower arm plus the hand was equal to 22.7923 minus 22.7369 plus 117.4483 minus 21.9952 plus 113.2985, or 208.8070 pound-inches.

Step 70. The total *increases* in kinetic energy of the upper arm was equal to 15.5036 minus 13.0320 plus 67.5299 minus 1.1652 plus 55.4083, or 124.2438 pound-inches.

ARRIVING AT FOOT-POUNDS AND HORSEPOWER

Step 71. The total increases in kinetic energy of the entire arm was equal to 208.8070 plus 124.2438, or 333.0508 pound-inches.

Step 72. The foot-pounds per minute of energy expended were equal to 333.0508 divided by (45) (.0001) (12) or 6168 foot-pounds per minute. (The terms 45, .0001, and 12 correct for cycle time, time units, and inches to feet respectively.)

Step 73. The horsepower expended in the movement of the arm from the button to the switch was equal to 6168 divided by 33000, or .1869 horsepower.

MANAGEMENT BOOKS

Recently Received

Problems in Marketing, by McNair & Hansen, 718 pages, New York, McGraw-Hill, $6.00

Public Administration, by W. Brooke Graves, 759 pages, Boston, D. C. Heath and Company, $6.00

Availability for Work, by Ralph Altman, 350 pages, Cambridge, Harvard University Press, $4.50

Layout Planning Techniques, by J. R. Immer, 430 pages, New York, McGraw-Hill, $5.00

The Scientific Appraisal of Management, by Jackson Martindell, 300 pages, New York, Harper & Brothers, $4.00

Peace by Investment, by Benjamin A. Javits, 242 pages, New York, Funk and Wagnalls Co., $3.50

The Philosophy of Thorstein Veblen, by S. M. Daugert, 134 pages, New York, Columbia University Press, $2.25

Introduction to Modern Office Management, by J. G. Frederick, 198 pages, New York, Business Bourse Publishers, $3.50

Cycles, by Edward R. Dewey & Edwin F. Dakin, 255 pages, New York, Henry Holt & Co., Inc., $3.50

Problems in Personnel Administration, by R. P. Calhoon, New York, Harper & Brothers, 540 pages, $5.50

Labor Dictionary, by Paul H. Casselman, 554 pages, New York Philosophical Library, $7.50

The Income of Society, by Elizabeth E. Hoyt, 753 pages, New York, The Ronald Press Company, $4.50

Problems in Labor Relations, by Selekman, Selekman, Fuller, 672 pages, New York, McGraw-Hill, $5.50

Situational Factors in Leadership, by John K. Hemphill, 136 pages, Columbus Ohio, Ohio State University

Titanium, by Jelks Barksdale, Ph.D., 591 pages, New York, The Ronald Press Company, $10.00

Effective Selling, by Breen, Thompson, West, 278 pages, New York, Harper & Brothers, $3.00

Depreciation, by Eugene L. Grant and Paul T. Norton, Jr., 472 pages, New York, The Ronald Press Company, $5.00

Time Out for Mental Digestion, by Robert Rawls, 45 pages, Scarsdale, New York, The Updegraff Press, Ltd., $1.00

Economics of Business Enterprise, by George J. Cady, 451 pages, New York, The Ronald Press Company, $4.50

Readings in Marketing, by McNair & Hansen, 769 pages, New York, McGraw-Hill, $6.00

Creative Power Through Discussion, by Thomas Fansler, 211 pages, New York, Harper & Brothers, $3.00

Competition Among the Few, by William Fellner, 328 pages, New York, Alfred A. Knopf, Inc., $5.00

Partnership for All, by John Spedman Lewis, 532 pages, England, Ker-Cros Publishing Company, Ltd.

The Handbook of Advanced Time-Motion Study, by L. Arthur Sylvester, 273 pages, New York, Funk and Wagnalls Company, $5.00

Labor Roundup

By Paul A. King

Assistant to Vice President for Personnel
Bigelow Sanford Carpet Company; Member of the New York Bar

IN THIS ISSUE

- **CAN YOU FIRE AN OPERATOR WHO SLOWS DOWN IF HE DOESN'T LIKE A RATE?**
- **WILL PENSION PLANS BE FORCED ON SMALL COMPANIES?**
- **HOW TO TRAIN REPORTERS FOR YOUR HOUSE ORGAN**
- **CONFIDENTIAL COUNSELING FOR TROUBLED EMPLOYEES**

Firing the Worker Who Doesn't Like Your Time Study

Employee Smith doesn't like time studies. So when a rate is set up he slows down. He doesn't bring the rate before the grievance committee — he just slows down.

Some companies have prepared booklets which try to sell the employee on time studies. But sometimes they don't work. The only answer may be: Fire the worker if he slows down on your rate.

Then the question comes up: Will the discharge stick under an arbitration?

The answer in most cases is "yes." Under most union contracts the worker cannot slow down if he disagrees with a rate or production schedule. His recourse is to protest the rate through the grievance procedure. (*National Machine Award*)

In one case, an employee contended that the change of method ordered by his boss increased his workload; so he did the job his own way. The Arbitrator said that "no mill can operate if the legitimate orders of the supervisor can be disregarded." (*Goodyear Clearwater Award*)

In fact, said another arbitrator, it makes very little difference "whether the company acted with wisdom or restraint." The contract required the employees to refer rate disputes to the grievance procedure. (*National Malleable and Steel Casting Award*)

Suppose the worker alibies that he slowed down because otherwise quality would suffer. That's not the worker's concern, but the boss' worry, ruled an arbitrator. (*Franklin Tanning Award*)

The principles found in the awards on the subject can be summed by quoting these two:

"In return for his wages an employee should work at a normal and reasonably consistent pace which will neither undermine his health nor deprive management of the benefit of his capacities. The deliberate failure of employees to give a fair day's work is a breach of discipline subject to management's normal disciplinary powers.

"The failure of an employee to meet the standard over a period of time in the absence of a valid reason raises a presumption that there is a refusal to give a fair day's work." (*Fobet Award*)

The second award: "An employee may not defy work orders, assignments, or production schedules and may not determine for himself or for a fellow worker what orders, instructions, assignments, or schedules shall be obeyed or honored (except in the rare and unusual event where a violation of law or danger of life or limb is imminent).

"If it is felt that they are unnecessary, improper or oppressive, redress may be sought under the grievance provision of the contract.

". . . the unilateral action of employees in concert in restricting normally scheduled production is a flagrant industrial offense. Unauthorized work stoppages and sitdowns are similarly regarded. Under the decisions of courts, labor boards, and arbitrators, they are held to merit discharge." (*Lake Shore Tire and Rubber*)

Pensions For Small Companies?

Not necessarily if the decision is left up to arbitrators. Two of them recently decided that the union's demand for pensions for a small company was unfair—at least until such time as the larger companies in the industry had settled for pension plans. "Why make pioneers out of the small outfit?" the Arbitrators asked. (*Bell Aircraft and Felters (textiles) Awards*)

Also encouraging to small companies is this news: The *Carter Carburetor Company*, a small St. Louis firm, signed a contract last November with the *United Auto Workers (CIO)* that said nothing about pensions. The UAW, you will recall, is the union that is all out for pensions—at least the big guns.

Safety Awards For Safety Conscious Workers

Every January, workers of the *Mutual Chemical Company of America*, a Baltimore Company, who go for the entire year without incurring a disabling injury on the job are presented with a safety certificate. If they go for 5, 10, 15, 20, and 25 years without such an injury, additional special awards are furnished.

These awards are given at the Company's annual Service Pin Presentation Meeting.

"What's News" Improves Company Magazine

You can rant and rave, fuss and fume, but any publisher will tell you that you can't have a good newspaper or magazine until you have reporters who know what makes news.

If your company's newspaper or magazine hasn't been ringing the bell—is dull, lifeless, and unread, why not start by training the reporters? In most companies, the reporters are production or office personnel — without professional training in news gathering and writing.

To train its news gatherers in the fine art of reporting, sometime ago *Western Electric* prepared this booklet: "What's News and How to Get It." Result? Excellently prepared publications.

The booklet starts by relating what is news. Tells how to write straight news, then special features, shorts and personals. There's a chapter on "telling the news in pictures" and finally some "do's and don'ts."

Transparent Window Envelope Cuts Payroll Costs

A penny saved here and there adds up to dollars. Here's a chance to do some of

(Labor Round-Up, Continued)

this kind of addition. *The Outlook Envelope Company* developed a cleverly designed window envelope for paychecks that will save the expense of addressing and at the same time will assure privacy and accuracy.

A window is cut into the envelope to conform to your check so that only the name and number of the employee are visible.

For information, write to them at *1001 Washington Boulevard, Chicago 7, Illinois.*

"Dial 3204 Service" Helps Solve Employee's Personal Problems

If you have a problem, a difficult decision, or anything that is worrying you . . . are upset about any part of your business or private life . . . are disturbed about how and where you can find the particular help you need . . . just want to talk things over with someone—in complete privacy—and in the strictest confidence—just Dial 3204.

However, unless you are an employee of the *Prudential Insurance Company* in Newark, New Jersey, dialing this number will not do you any good.

Realizing that emotional upsets affect the worker's job performance, and also knowing that such upsets often come about because the worker locks up his problem within his breast where it haunts him, *Prudential* developed a Counseling Center for employees. Any employee can dial 3204, the telephone extension of the center and make an appointment to talk over any problem that may be bothering him.

Each counselor has had extensive training in modern counseling methods. In addition, the counselors have been selected for their friendliness—their natural liking for people—their ability to respect confidences—their interest in helping others help themselves.

The average interview takes about an hour.

Prudential employees are told about the service in an attractive booklet called "Dial 3204."

Emerson Trophy Standings

Chapter Performance Award Plan

As of February, 1950

CHAPTER	TOTAL
Cleveland	2794
Washington	2613
Philadelphia	2349
Pittsburgh	1438
New York	1086
Cincinnati	1060

Management Bookshelf

FOUNDATION TEXT

The Engineering of Organization and Management

BY ROBERT TEVIOT LIVINGSTON
247 pp., 1949, McGraw-Hill Book Company, $3.00

THIS book should serve usefully the purpose for which it was designed, to furnish a foundation and outline for a series of more specialized courses. It draws together into a systematic and reasonably compact outline, much of the accepted theory of organization. It describes the typical cycle of action: deciding, planning, preparing, operating, and revising. It discusses the hierarchal structure of organization, from stockholder to supervisor, and the means by which decisions are formulated, transmitted, acted on, and results are appraised.

Analysis of Functions

In his chapter *"Analysis"* the author usefully summarized the various bases on which functions may be differentiated, as: on a location or temporal basis, by products, processes or purposes, by clienteles, on the basis of personal skills and compatibilities. His chapters on "Management" and "Leadership" are persuasive.

The style throughout is clear but at points over-explicit. In the attempt to combine compactness with completeness, the cases and illustrations with which the author doubtless enlivens his oral presentation have been largely omitted. These are faults which can be overlooked by the purposeful reader.

While at various points the author emphasizes the necessity of securing the cooperation of subordinates, little attention is given to the means by which this cooperation is obtained, and the ideas and wishes of the members of a group are integrated. Throughout, the assumption seems implicit that stockholders or top management make the decision and that the only remaining problem is the provision of efficient machinery for elaboration and execution. While THE ENGINEERING OF ORGANIZATION AND MANAGEMENT is not alone in this omission I found it troublesome in a book which purports to deal with the whole of organization rather than with its delegational phases only.

H. P. DUTTON

PICTURE OF PRODUCTIVITY

U.S.A.: Measure of a Nation

BY THOMAS R. CARSKADON
AND RUDOLF MODLEY

Macmillan Co. 101 pp, paper bound. $1.00

"ON THE sober record of our actual past achievements and future possibilities, as examined in these pages, we Americans have the most productive economic machine in all human history. It's up to us to run it." These closing words of *"USA: Measure of a Nation"* cover its main thesis. The book itself offers an impressive array of proof to substantiate this assertion.

The same facts and conclusions have previously been presented in the Twen-

(Continued on Page 28, Col. 2)

SOCIETY NEWS

NEW STUDENT CHAPTERS

Chapter	*Location*	*Student Advisor*
University of Arkansas	Fayetteville, Arkansas	W. G. Holder
University of Oklahoma	Tulsa, Oklahoma	Ronald B. Shuman
Michigan State College	Lansing, Michigan	S. E. Bryon
College of William and Mary	Williamsburg, Virginia	Charles L. Quiltmeyer
University of Chattanooga	Chattanooga, Tennessee	Daniel A. Preston
University of Mississippi	University, Mississippi	R. F. Wallace
Tulane University of Louisiana	New Orleans, Louisiana	Paul L. Taylor

JAMES M. APPLE of the Detroit Chapter is the author of a new book on "Plant Layout and Materials Handling" which will be published by Ronald Press about May 1950. Mr. Apple is also one of the featured speakers scheduled to appear at the *Fifth Annual Time Study and Methods Conference* to be held April 20 and 21 at the Hotel Statler in New York City. His subject is *"Setting Standards on Paced Jobs"*.

THE INDIANAPOLIS CHAPTER conducted a group survey of rating concept at a Time Study meeting on March 9. The S.A.M. Rating Project film was shown to a group of Time Study Engineers, and after the survey is completed each participant will receive a copy of his rating form and a "correct" answer sheet. The Indianapolis Committee in charge of this activity is made up as follows: George A. Myers, Carl W. Darnell, Rick R. Hall, Glenn S. Clark.

MORRIS L. COOKE, of the Philadelphia Chapter, has been selected by President Truman to serve as Chairman of the Temporary Water Resources Policy Commission.

THE ATLANTA CHAPTER heard Mr. H. C. Blankmeyer, assistant to the Vice-President, Joseph E. Seagram & Sons Inc., speak at their April meeting on "Seagram's Management Training Program."

DR. LUTHER H. GULICK, a Director of the New York Chapter, has been appointed Executive Director of the Mayor's Committee on Management Survey of the City of New York. Carl Heyel, President of the New York Chapter is Executive Assistant. Chairman of the Committee is Comptroller Lazarus Joseph. Dr. Gulick is widely known as President of The Institute of Public Administration.

JOHN E. FONTAINE, President of the Houston Chapter has been appointed Assistant District Manager, Gulf Coast District, Graybar Electric Company, Inc. He was formerly Manager of Graybar's Houston office.

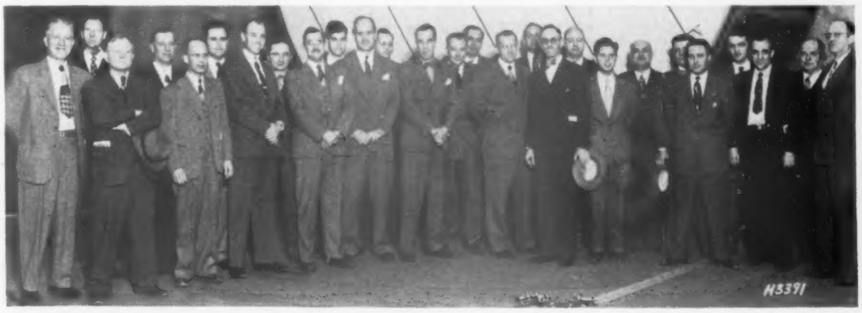
The NEW YORK CHAPTER has postponed their regular April meeting, originally scheduled for April 20, 1950, in order to avoid a conflict with the date of the Fifth Annual Time Study and Methods Conference, which will be held on the 20th and 21st at the Hotel Statler.

The New York Chapter Manufacturing Group will hold an all-day session on March 30, 1950, at the Biltmore Hotel. Russel F. Hurst is in charge.

GLENN L. GARDINER Northern New Jersey Chapter Member, and author of many books and articles on Foreman Training and Human Relations, has been quoted as an authority many times by Dr. Albert E. Wiggam in his widely syndicated newspaper feature "Let's Explore Your Mind".

CINCINNATI CHAPTER, at its March meeting, heard Mr. Mason M. Roberts, General Manager, Frigidaire Division, General Motors, speak on "Competition—Exit the Order Taker."

TRENTON CHAPTER, "Round Table" Panel on *Time Study and Methods.* Left to right, seated: J. R. Bailey, Supervisor, Management Engineering, E. I. duPont deNemours; J. Cryan, Superintendent of Labor Standards and Methods Improvement, Ternstedt Division, General Motors; Thomas E. Kelly, Director of Organization and Methods Department, Atlantic Refining Co. (Moderator of the Panel); Earl R. Groo, Supervisor of Cost Control, Standard Pressed Steel Co. (Chairman of Committee on Round Tables); William C. Ridge, Manager of Standards Engineering, John A. Roebling Sons. Standing in Rear: Edward A. Necker, Methods Engineer, Thermoid Co.



MILWAUKEE CHAPTER visits two Heil Company plants. Forty-five members and guests enjoyed their tour through Plants #1 and #3. Part of the group is shown above. Trip was arranged by S.A.M. members "Cy" Hastings, Personnel Director, Heil Company; and "Dave" Blattner of American Appraisal Company.

Management Bookshelf (cont'd)

(Continued from Page 26, Col. 3)

tieth Century Fund's monumental work *"America's Needs and Resources"*. The mere massiveness of that volume, however, and its great detail and elaboration predestined it for the book shelves of the relatively few professionals and intellectuals. What this new, far simpler and shorter version attempts to do is to make the basic facts available for broad general distribution. This it achieves admirably, thanks to the clear presentation by Carskadon and the really outstanding use of charts and pictographs by Modley (his pictorial dramatization of our steady growth in machine power and its effect on our productivity is a classic).

BOTH SIDES OF THE COIN

The book may well find its greatest usefulness in serving as an eyeopener for those doubting Thomases and congenital pessimists who haughtily dismiss as daydreaming the experts' forecasts of future growth for this country. By showing the extent of our progress achieved to date and the challenging tasks still to be accomplished, it should go a long way toward shattering the spurious conception of ours as a mature economy. Wisely, the authors have stayed clear of political controversy by refraining from advocating any specific political means of implementing this future growth.

Nor have the authors yielded to the temptation to present only the positive side of our economy. Equally well documented are our deficiencies, some of which are not nearly well enough known to the majority of our people. For instance, the fact that there are fewer practicing physicians today in relation to our population than there were at the beginning of the century will come with striking novelty to many. The extent to which slum areas have pervaded our cities and the somewhat surprising fact that metropolitan districts actually contain proportionately fewer of these blighted areas than smaller cities are other similar surprises. Finally, it demolishes one other common fallacy by proving that in the so-called spendthrift 30's government expenditures actually increased less per capita than during the period 1913-1932.

The book probably makes its greatest contribution in appraising the cost of *all* desirable improvements in our standard of living. Shooting for 1960 as the goal, it details that it would require less than \$2½ billion additional to provide proper medical, dental and nursing care for every American, that at an annual cost of \$1.4 billion over our present housing expenditures we could wipe out every slum dwelling in America and that for less than \$1.8 billion additional appropriations we could gain adequate education by well-trained teachers for every student.

These and related social goals, described as Utopian by so many of our contemporaries, can all be achieved if we could superimpose on the natural growth of our economy an additional 8% gain in productivity during the next 11 years. To do this is possible, but it will take intelligence and cooperation on the part of our entire society. *"USA: Measure of a Nation"* can make a real contribution by broadening public understanding of these requirements and opportunities.

LEO CHERNE